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Box cars of 70,000 lbs. capacity have been built at the shops of the Northern Pacific R. R. for the special purpose of carrying grain. There are six sills, 5x9 ins., the center sills being spaced 13¼ ins. apart in the clear, the intermediate sills 6⅝ ins. from the center sills, and the side sills 26½ ins. clear from the intermediate sills. There are four 1½-in. truss rods (upset to 1⅞ ins. for nuts and turnbuckles), extending the whole length of the frame, the truss depth being 18½ ins., and the struts spaced 8 ft. 10½ ins. apart. The draft rigging is between the center sills. The body bolsters are of iron plates riveted together. Fox pressed steel trucks are used, with 33-in. wheels, and a wheelbase of 5 ft. 2 ins. The general dimensions of these cars are as follows:

Length over end sills	42	ft.	0	ins.
" inside	41	"	0	"
Width over side sills	9	"	1	"
" inside	8	"	6	"
" over roof	9	"	11⅛	"
Height from sill to roof plate	7	"	7	"
" " rail to side of roof	11	"	9	"
" " " " top of roof	12	"	5½	"
" " " " bottom of sill	2	"	7¼	"
" " " " c. of coupler	2	"	10⅝	"
Wheelbase, truck	5	"	2	"
" total	37	"	0	"
Body, cross section	77 sq. ft.			
" cubic capacity	3,157 cu. ft.			
Weight of body	20,000 lbs.			
" " two trucks	12,000 "			
" total	32,000 "			
Freight capacity	70,000 "			

The most serious railway accident of the week was a head collision on the New York Central R. R. near Fairport, N. Y., Feb. 12. An open switch at a crossover turned an eastbound stock train onto the westbound track, but the engineman apparently did not notice that he was on the wrong track, and the train came into collision with a westbound train. Three men were killed and three injured, and a number of cattle were killed and cars smashed, blocking all four tracks.——A train on the Union Pacific, Denver & Gulf Ry. was blown from the track as it crossed Fisher's Gulch, Georgetown, Colo., Feb. 9, by a strong wind blowing down the gulch. The locomotive kept the track, but the tender and three cars were blown over and rolled down the bank. Two persons were badly hurt and about six others more or less cut and bruised.

The vapor from gasoline used in cleaning carpets in a Pullman car at Pittsburg, Pa., was exploded by fire in the heater, on Feb. 15, smashing the windows and interior fittings, and injuring three of the car cleaners. —A gasoline explosion occurred on a pleasure launch at Eureka, Cal., on Feb. 7. The boat was destroyed but the passengers escaped.

A grade crossing collision between an electric car of the Second Ave. Traction Co. and a switching engine of the Baltimore & Ohio R. R. occurred Feb. 7, at the Rankin crossing, between Pittsburg and McKeesport, Pa. The conductor went ahead of the car, which did not stop, and when he saw the engine it was too late to stop the car. The conductor was killed. At the inquest the motorman was censured for not stopping the car at the crossing.

A landslide blocked the Baltimore & Ohio R. R. tracks near the South 10th St. bridge, Pittsburg, Pa., Feb. 13. There are said to be indications of extensive movement and loosening of the steep hill which rises above the tracks.

A terrible explosion occurred in the Vulcan coal mine, Newcastle, Colo., Feb. 18, and it is thought that all of the 50 men in the mine at the time must have been killed by the explosion or the gas.

The four youthful train wreckers who caused the accident at Rome, N. Y., on the New York Central and Hudson River Railroad on Nov. 19 have all been indicted for murder in the first degree.

The 48-in. steel water supply conduit of Newark, N. J., is to be paralleled by another 48-in. steel main for the first five miles from the Macopin intake to Pompton Notch, and by a 42-in. main for the remaining 16 miles to the Belleville service reservoir near Newark. This is the result of numerous conferences between the officials of the city of Newark and those of the East Jersey Water Co., since the original pipe line was found to be insufficient in capacity. The agreement has yet to be confirmed by the directors of the company and embodied in a contract. The conditions of the preliminary agreement are that the 42-in. section shall be of sufficient strength to deliver water through the present 36-in. steel branch line, five miles in length, to the South Orange high service reservoir, at a pressure equal to an elevation of 300 ft. above sea level. The city agrees to accept the present 36-in. steel main between the two reservoirs as complying with the contract requirement for a delivery of 25,000,000 gallons a day, and to pay the company $10,000 in cash. The latter sum was agreed upon in this way: The company proposed, had the above agreement not been made, to lay a 42 and 36-in., instead of 48 and 42-in. pipe, for 5 and 16 miles, respectively. It offered to build the larger conduit for the difference in cost. Mr. Clemens Herschel, M. Am. Soc. C. E., Chief Engineer of the company, estimated this as $133,000, and Mr. Morris R. Sherrerd, Engineer of the Newark Water Department, estimated it at $107,000. The company finally agreed to call the difference $110,000 and to knock off $100,000 from this if the city would accept the 36-in. line to high service, notwithstanding its deficiency of 2,500,000 gallons. It will be noted that the carrying capacity of the 36-in. line, five miles in length, is deficient by only 10%, whereas the first 48-in. main, 21 miles long, was deficient nearly 30%. The company states that it has let the contract for the second line under heavy guarantee that it be completed by Nov. 1, 1896. We understand that the plates are to be made by the Carnegie Steel Co. The contractors for the pipe line are Gillespie Bros., of Pittsburg.

Lake George was recently suggested as a source of water supply for all the cities in the Hudson River valley, as well as for New York city and vicinity, by Mr. J. L. Manny, of New York. Mr. Peter Hogan, of Albany, points out in a letter to the New York "Tribune," in which the above suggestion appeared, that Lake George has an elevation of only 315 ft. above tidewater, which is about the level of the high water service of Troy, Albany, Hudson and Poughkeepsie; also that the average discharge from the lake is only 100,000,000 gallons per day, whereas New York city alone already uses nearly double this amount. By conserving the water from the Croton and protecting the watershed Mr Hogan urges that New York will have a plentiful supply for years to come, while by using salt water for street cleaning and sewer flushing, as already recommended by Mr. Geo. W. Birdsall, Chief Engineer of the Croton Aqueduct, the time during which the Croton supply will be sufficient would be extended still further.

The repairs on the Queen Lane reservoir at Philadelphia, described in our issue of Oct. 24, 1895, have already checked the leakage to some extent. These repairs consisted in putting in a concrete foot wall at the inner slope and lining a part of the slope with asphalt. It having been reported in the newspapers that the reservoir had been filled, a communication from this journal was sent to Mr. John C. Trautwine, Chief of the Bureau of Water, asking him if the statement was true and what effect the repairs had had upon the leakage. To this letter Mr. Trautwine replied as follows:

Replying to your favor of Feb. 6, I would say that the Queen Lane reservoir has not been filled, and no orders have been issued for filling it. The asphalt work which we have thus far carried out was not expected to render the basins water-tight, but merely to protect the slopes against the action of the winter weather. We, however, began putting water in the reservoir as soon as these repairs were completed; first, in order to cover the bottom and thus protect it from frost, and, second, to get as much water in as we safely could. We therefore pumped water in gradually, stopping, at times, to observe the rate of leakage. At a depth of 6 ft., before the repairs, the total loss from the north basin was about ½ in. per day, and from the south basin, 1 in. After the repairs, at the same depth, it was about 1-6 in. from the north basin and ¼ in. from the south basin. At 10 ft., before the repairs, the loss was 7-10 in., and 1¼ in. per day from the north and south basins, respectively; while, since the repairs, it has been ⅜ of an inch from the north basin, and ⅝ in. from the south basin. We have not carried the depth as high as 11 ft. (intended depth 30 ft.), and we are just now drawing upon the reservoir to avoid the necessity of sending into the direct pumpage district the intensely muddy water which is coming down with the flood which began yesterday (Feb. 6). In comparing the losses at 6 ft. depth, it is only proper to bear in mind that before the repairs the observations at that depth were made after a depth of 10 ft. had been reached, and as the water was receding, so that the basin was under the disadvantage of any damage already done under the 10-ft. head; whereas, after the repairs, the observations at 6 ft. depth were taken as the depth was being increased, and while 6 ft. was the maximum.

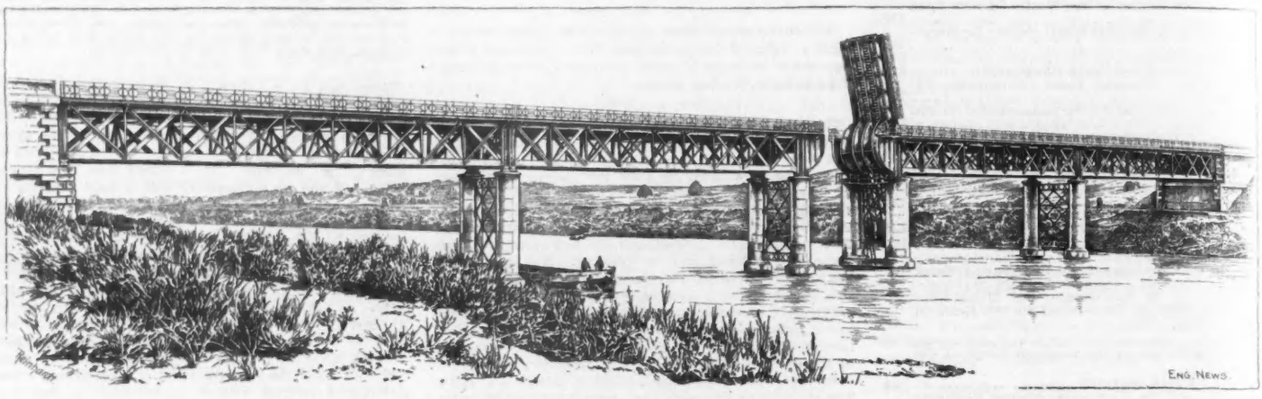
Three bids for a "garbage crematory franchise" were recently received by the board of supervisors of San Francisco, Cal. The franchise offered was for 50 years. Mr. F. E. Sharon bid $2,150 in cash, 2% of the gross receipts for the first 15 years and 5% for the remaining 50 years of the franchise. It is stated that this bidder intended to put up a crematory with a daily capacity of 250 tons. Mr. A. M. Skelly offered $1,105 in cash, 1% of the gross receipts for the first 15 years, 2% the next 15 and 3% for the last 20 years. Mr. L. V. Merle, "a clothing merchant," bid $5,500 cash and promised no part of the gross receipts. The bids were referred to the Health and Police Committee, which, on Jan. 31, decided to recommend that the franchise be granted to Mr. Merle. This action is justified, according to reports, by claiming that the yield from the offers of percentages of gross receipts is so uncertain as to make this cash offer the highest one. The Merchant's Association is credited with a determination to fight the award, because given to the lowest bidder, and because the term of the franchise is too long. It is also said that both of the other bidders will fight the award. From the information at hand it appears that the franchise is for receiving and disposing of garbage brought to the crematory by private collectors, the price for such disposal being fixed in the franchise at 20 cts. per cu. yd.

Five bids for the final disposition of the garbage of New York City for five years from June 1 were received on Feb. 17, by Col. Geo. E. Waring, Jr., M. Inst., C. E., Commissioner of Street Cleaning, and on Feb. 18 all the bids were rejected by the Board of Estimate and Apportionment. It is very probable that an opportunity to put in new bids will be given within three weeks, the bids to be on the lump-sum basis. The bids received were as follows, the prices being per ton of 2,000 lbs.: H. L. Fox, 221 W. 57th St., New York City, 50 cts.; Merz Universal Extractor & Construction Co., of 788 Broadway, New York City, 90 cts; Z. F. Magill, Troy, N. Y., $1.15; R. Walter Peterson, 2,017 N. 13th St., Philadelphia, $1.44; Wm. Kelly, 317 W. 51st St. and I. S. McGlehan, 26 Cortlandt St., New York City, $1.48 The Fox, Magill and Kelly & McGlehan bids were for burning the garbage, and the Merz and Peterson bids, for treating it by utilization processes. Mr. Fox proposed to use the Vivarrtas furnace, Mr. Magill (presumably) the Brown, and Kelly & McGlehan an inclined revolving cylinder furnace, invented by Mr. McGlehan, but not yet put into practical use. The Merz people have utilization plants in operation at Buffalo, Detroit, Milwaukee and St. Louis, all of which were described at length in our issue of Nov. 1, 1894. Mr. Peterson is interested in the big utilization plant of the Arnold system at Philadelphia. This is the only Arnold plant now in operation in this country. The system was described and illustrated in an issue of March 28, 1895. Mr. Fox proposed to build Vivarrtas furnaces at each of the garbage dumps, some seventeen in number, and Mr. Magill to build one large plant in the city. The other bidders, we understand, intended to remove the garbage by scows to a point some distance from the city. The Vivarrtas furnace is in operation at Scranton, Pa., and the Brown at Wilmington, Del., and Troy, N. Y., the latter plant being owned by Mr. Magill, who has the contract for the collection and disposal of the garbage of that city. The new call for bids will probably be on the basis of a lump sum per year, regardless of the amount of garbage, instead of on the price per ton. The present bids were rejected largely because the information received in response to requests for proposals indicated that more favorable offers could be secured under the above proposed plan. Some of the companies in the garbage business consider the city's estimate of 800 tons of garbage per day too high. The actual amount being uncertain, it might be easier, it is urged, to induce capital to take up the enterprise on the lump sum basis. The amount of garbage to be handled would be problematical, but the amount of compensation would be certain.

AN ITALIAN DRAWBRIDGE

By Chas. J. Webb.

The accompanying illustration shows an interesting bridge which has been recently constructed over the River Tiber at a point about $1\frac{1}{4}$ miles from Rome. The structure was designed by the late Signor Angelo Vescorali, chief engineer of the Rome water supply. The bridge was built to facilitate the transport of cattle from the rural district on the right hand bank of the Tiber to the new abattoir in Rome. The superstructure of the bridge, which measures 563 ft. over the abutments, is of wrought iron, the four side spans having girders 114 ft. 8 ins. long, and the central span a lifting leaf 41 ft. 7 ins. in length. The width of the bridge between the hand railings is 30 ft. 5 ins. The main girders are supported by two masonry abutments



BRIDGE OVER THE TIBER NEAR ROME, ITALY. Angelo Vescorali (deceased), Chief Engineer.

and four tubular columns or piers, the space between the centers of the two middle ones being 49 ft. 2 ins., allowing a free passage for sailing vessels from the sea when the lift span is raised.

The chief point of interest in the construction of the bridge is the hydraulic mechanism for raising and lowering the central span. As already stated, the lifting leaf is 41 ft. 7 ins. long. Its width between the railings is 19 ft. 6 ins., and it turns about its axis through an angle of 75°. It is provided with an extension 38 ft. 3 ins. long (shown in the illustration), at the end of which is fixed a counterweight of 12 tons, which almost balances the weight of the movable leaf. In order to close or open the middle span, two floating counterweights, 3 ft. 6 ins. in diameter and 10 ft. 4 ins. long, are provided, connected by flat steel ropes to the peripheries of two segments of 9 ft. 8 ins. radius attached to the movable portion. These floating counterweights work inside cast iron cylinders, 3 ft. 9 ins. in diameter, located in the two columns or piers. These cylinders may be filled with water or emptied by means of a valve mechanism situated on the bridge. To raise the drawbridge, the cylinders are emptied, the floating balance thereby falling and raising the movable leaf to the extent previously mentioned, i. e., through an angle of 75°. To lower the drawbridge again, the reverse operation of the hydraulic valves allows water from a tank to again flow into the cylinders, the bridge falling by gravity. The weight of the whole of the movable parts is 164,864 lbs., and the operation of raising or lowering the leaf occupies a period of five minutes.

The late Signor Vescorali, whose death took place in February, 1895, was the foremost hydraulic engineer in Rome, and for more than 23 years he served the municipality of that city. He succeeded in bringing to a successful conclusion some very important works, among which may be mentioned the embankment of the River Tiber, the drainage of the entire city of Rome, and the erection of reservoirs for drinking water and its distribution throughout the city. The principal works of Vescorali were, however, the monumental bridges over the Tiber, among which may be mentioned the Marzherita and Garibaldi bridges. His project, approved by the Italian Government, for diverting the River Anio from Tivoli to Rome, for agricultural purposes, is now under way, and when completed will be the means of enriching and embellishing the country around Rome.

CENTRAL WATER SUPPLY STATIONS FOR RAILWAYS.

By Charles A. Hague, M. Am. Soc. C. E.

(With inset.)

An important detail in operating a railway is the provision of a proper water supply for the locomotives; the questions of quantity and quality both calling for careful consideration. The requisite quantity must be had, and if the quality is bad for boilers an allowance for replacing tubes and renewing fireboxes must be made in the repair account. With a large number of engines, this may amount to a considerable sum in addition to the water rates charged by most cities, and might be sufficient to justify a very large outlay for water pipes to distribute a quality of water free from scale-forming impurities. The difference in the quantity of coal consumed with and without fouled tubes would also enter into the question. It is obvious that a clean soft water, practically free from the various impregnations of lime, magnesia and other objectionable components, is so desirable for boilers of such high horse-power, in proportion to size, that it will pay to go to considerable trouble and expense to secure a supply of this important element, and thus avoid most of the expense due to overhauling, cleaning and repairing the boilers.

The comparative economy of one large or main pumping station, as against numerous small tank stations, if steam pumps are used in the latter case, must also be considered. At terminal stations situated on the seaboard, the cost of water for engines is likely to be high, and the water not often of the best quality, so that the question of securing a supply some distance out on the line for the terminal and for the intermediate stations may be well worth looking into.

Two or there years ago the management of the Long Island R. R. decided that a better water supply was an absolute necessity, as the water then being used limed the boilers to an extent that necessitated a complete change of tubes every year in nearly 200 engines which took water at Long Island City. After considerable and careful investigation, it was decided that the ground near Jamaica, L. I., promised a liberal supply of pure soft water, and the opinion so formed has been completely justified by the results. The entire work, comprising the wells, necessary mains, both for suction and distribution, standpipe, and pumping station with machinery and boilers, together with all necessary appurtenances, was put in by the Long Island R. R. Co., under the direction and supervision of Mr. Charles M. Jacobs, consulting engineer for the company, the work being in charge of Mr. J. V. Davies, C. E. After the works were completed and put in operation, the Montauk Water Co. was formed, and the entire plant and business was transferred to the water company, which now operates the works, supplying water to the railway and also to the Standard Oil Co., Fleishman Distilling Co., Haberman Mfg. Co., Preston Fertilizer Works and other establishments in the vicinity. The amount of water pumped per day averages about 1,500,000 gallons, the maximum approaching 2,000,000 gallons. The affairs of the water company are conducted under the general management of Mr. J. V. Davies, its chief engineer.

In Fig. 1 is shown a vertical section of one of the wells, of which there are fourteen at present, although provision has been made for extensions when desirable. Beginning at the top, there are about 5 ft. of soil, 6 ft. of clay and then about 1 ft. of sand and gravel formation. Immediately beneath this is the principal water-bearing ground, utilized with these wells to a depth of about 25 ft. The wells vary slightly, but a description of one will answer all purposes. The entire depth is 38 ft., and the wells are lined with a light iron casing 24 ins. diameter, which is removed after the well is sunk. Within the well is placed a vitrified clay pipe made in short sections and perforated with a series of short narrow slots, these slots being made before the pipe is baked, so that their surfaces are hard and clean. This clay pipe extends to within 3 ft. of the bottom of the well, the lower 3 ft. being packed with gravel, as well as the sides of the well in the annular space left by the clay pipe, as shown. The perforations are not generally carried above the water-bearing ground. A 4-in. suction pipe with a foot valve attached is carried down nearly to the bottom of the clay pipe, and then the space between the clay pipe and the suction pipe is closely filled with screened gravel. A close-fitting cover at the top through which the suction pipe passes, completes the well; a stop valve being attached to the suction in case a well should need to be isolated for any reason. This form of well, known as the Dollard well, gives most excellent results. When properly made it will keep clear and clean for a long time, and it will be noted that it gives a pump all of the advantages of an open well.

Fig. 2 is a general plan showing the locations of the wells. At different times various observers have claimed to have noticed evidence of some sort of a connection between the ground waters of the main land in Westchester County and those in Long Island, and the projectors and constructors of this water plant aver that there is a flow perceptible in the ground water, from the north towards the south; hence the peculiar arrangement of the wells, as shown. The longest distance between the wells is from north to south, thereby giving more time for the water to reach the succeeding well after passing by the first one in the line of flow, each pair of wells in the north and south line taking care of themselves somewhat independently of those to the east and west. The locations of the wells, the size and length of the various connections and parts of the suction pipe are plainly indicated upon this plan. A pond of surface water used for condensing purposes for the pumping engines has an elevation above sea level of 33.1 ft., the contour lines giving an idea of the ground formation about the pumping station. The different suction pipes culminate in a 16-in. suction main, which enters the engine house and carries the water to the pumps. The machinery consists of two Worthington horizontal, condensing, triple-expansion pumping engines, each having a capacity of 2,000,000 gallons in 24 hours, the engines being in duplicate to provide against accidents. The boilers are of the ordinary return tubular type, carrying a working pressure of 125 lbs. per sq. in. The engine and boiler house, combined in one building, is a neat and substantial brick structure, with living rooms above the engine room for the enginemen and firemen.

Fig. 3 shows a general plan and profile of the line of the force main from the pumping station to a point between Jamaica and Dunton, to Long Island City, the extensions at the western end supplying water to the freight houses, and the slips for the Long Island R. R. ferryboats. This main consists of 8½ miles of 12-in. pipe, and one mile of 10-in. pipe, and cost in place approximately $60,000, the company doing the work of laying by day work. In the railway yard at the west end is a water tank with a capacity of 50,000 gallons, and from this tank, and through the medium of four Porge water columns, the locomotives are supplied; no water being drawn from the main for engines excepting in emergencies. The water for station purposes, and for washing cars is supplied from the main in the usual manner as from the city pipes. In the profile the references are from mean low water at sea level, as shown by the scale at the left hand. One of the peculiar features in the work is the crossing of the Dutch Kills, a small creek running into Newtown Creek. The crossing was made with 10-in. black wrought-iron pipe, tested to a pressure of 300 lbs. per sq. in. The main following the tracks to the bridge, is caused to dip at an angle of 45° by suitable fittings, the change from cast to wrought iron pipe being made here. The pipe then extends downward for a distance of 35 ft. on the angle, then another 45° bend restores the horizontal line, at the lowest level of the creek bottom, or a trifle lower; then a straight run of 185 ft. carries the pipe to a point at which another 45° bend gives the direction for again reaching the regular level beneath the right of way alongside the tracks, where is still another 45° bend and a connection to the cast-iron pipe main. At present there is no water delivered further east than the company's shops at Jamaica, and between that point and Long Island City, four railway stations and all of the signal towers are supplied; there are fire hydrants at various points, and the main can be shut off by suitable gates every three-quarters of a mile when necessary for inspection or repairs to main or connections.

Between Bushwick Junction and Glendale there is a stand-pipe attached to the main; this stand-pipe having a diameter of 20 ft. and a height of 90 ft. The details of this are seen in Fig. 4.

The quality of the water secured is all that could be desired, it being a nearly pure, soft, sand-strata fluid, giving the most satisfactory results in the boilers. An analysis shows practically no impurities, and only the faintest trace of carbonate of lime, this being so limited in quantity as to produce no perceptible effects in a locomotive boiler even after extended use. As occasion demands, probably in the near future, the mains will be extended eastward, and so continued as far as the furnishing of the water promises to pay for the outlay.

THE FRICTION IN SEVERAL PUMPING MAINS.*

By Freeman C. Coffin, M. Am. Soc. C. E.

Having recently had an opportunity to experiment upon several pumping mains, and in a practical manner to determine the friction caused by the flow of water at differing velocities, it seemed that a short description of the mains, the experiments and the results might be interesting to the members of the association, as well as give an opportunity to make a public record of them for comparison with the formulas in use.

The velocity or quantity of water was obtained from the revolutions of the pump with a proper allowance for slip in each case. The friction head was measured by the difference of the static and dynamic head, as shown on the pressure gage connected with the main. I believe that there was no error from the reading of the pressure gage to exceed 1 ft., and in most cases much less, as the gages were graduated to a large scale. It was my endeavor to have all such errors, if any, on the safe side, or on that of increased friction. The gages were so nearly accurate that there would be no appreciable error in the range covering the increase of pressure due to friction.

The static head was observed before the pumps were started and in cases where the water was pumped into a stand-pipe account was taken of the rise of water or increase of static head. The observations of the pumps were carefully made, both as to revolutions per minute and length of stroke. The extreme accuracy of careful made hydraulic experiments was not possible. I believe, however, that substantial accuracy, sufficient for practical purposes, was obtained. The fact that the mains were long tended to reduce the proportional error due to errors of observation.

(The results for the several mains have been consolidated in one table.—Ed.)

*A paper read before the New England Water-Works Association, on Feb. 12. This paper will be published in the "Journal of the New England Water-Works Association."

Ipswich Main.

This was a compound main, consisting of 9,060 ft. of 12-in. pipe, with no bends except those of long radius, no side outlet and perhaps one-half dozen house services; 1,000 ft. of 12-in. pipe continuing from the first one, but with a side outlet 8 ins. in diameter at its junction with the first portion and a 6-in. side outlet at about one-half of its length; these pipes passing into a system in such manner that I estimate that but one-half of the flow will pass through the 1,000 ft. of 12-in. pipe. It must be admitted that there is an element of uncertainty in this part of the line. However, it would make but little difference in the total result whether one-fourth, one-half or three-fourths of the water passes through this short length, as the total computed friction through it is very small, as shown by the seventh column of Table I.

The remainder of the line to the reservoir was 1,150 ft. of 14-in. pipe, without branch or service. The total flow from the pump, with the exception of the ordinary consumption, passes through this line into the reservoir. The total daily consumption was 40,000 gallons. Assuming that 75 % of this was used in the twelve day hours, then the average day-hour consumption was 42 gallons per minute, which was the amount deducted from the total to get the amount flowing through the 14-in. pipe.

There was one right-angled bend made by a globe special at the junction of the 12 and 14-in. lines. There were several gates and globe special hydrant branches on the lines, as well as two check valves.

The table gives the results of these experiments, and a comparison of the actual with the computed friction. The latter was calculated by the Chezy formula

$$V = C\,(rs)^{\frac{1}{2}} \text{ or } s = \frac{V}{C^2 r}$$

using for the coefficient C the value given by Hamilton Smith, Jr., as estimated from his diagram for the different sizes of pipe, as closely as possible.

Walpole Main.

This is a compound main consisting of 6,950 ft. of 12 and 8,900 ft. of 10-in. pipe. There was at the time no consumption and no side mains open to complicate matters. There were four right-angle bends made with globe specials. There were six long bends, many hydrant and other branches and gates upon the line.

The water was pumped into a stand-pipe. The static pressure was observed before the pump was started and after it was stopped, at the end of the experiments. The static head for each experiment was estimated in proportion to the amount of water pumped into the stand-pipe at the time the experiment was made. The total rise in the stand-pipe was 4½ ft. The slip was taken as 2½ %.

Attleboro Main.

This is also a compound main consisting of 6,400 ft. of 16, 10,750 ft. of 14, and 375 ft. of 12-in. pipe. The 16-in. pipe, which was nearest the pump, was entirely free from open side outlets, as was also the 14-in. The latter, however, supplied at its farther end, or end nearest the stand-pipe, about 250 people; their day-hour draft would be 10 or 11 gallons per minute, but being so near the end of the 14-in. pipe, would not affect it appreciably. The 12-in. pipe carried from the 14-in. to the stand-pipe all the water pumped except that used by the town. This is about 400 gallons per minute, on the assumption that 75 % is used from 6 a. m. to 6 p. m. This amount, of 400 gallons was deducted before the friction in the 12-in. pipe was computed.

The stand-pipe was provided with a gage recording by electricity in the pumping station. The static head was read from this simultaneously with the dynamic head from the pressure gage on the main. The slip was called 2 %. There were three right-angle bends and numerous branches and gates on the line.

Taunton Conduit.

This is a simple main of 36,700 ft. of 30-in. pipe. It is used as a suction or supply main for the pump which takes the water under a static head of 66 ft.

These experiments were very satisfactory, as far as they went, but the range of velocities was very low, from 0.47 to 1.15 ft. per sec. The velocity was limited by the safe speed of the pump. The probable slip was taken as 5 %.

Taunton Pumping Main.

This is a compound main, composed of 6,000 ft. of 24-in. pipe and 50 ft. of 18-in. pipe. There are no branches or services upon it. The actual friction in this main exceeded the computed friction by a large percentage, as shown by the table.

General Discussion of Results.

I was surprised to find that the friction in the Ipswich line (the first one experimented upon) was less than the computed friction for clean, straight pipes. I expected that the gates and branches and two check-valves upon the line would cause considerable loss of head, and make the actual friction head above that of straight pipes, as computed by the formula named. The experiments on the Walpole pipe show about the same results and seem to confirm the first.

The older lines, Attleboro, and the 30-in. Taunton line, show slightly different results, especially in the higher velocities, where the actual friction head is greater than the computed head. The friction in the 24-in. Taunton line was still more in excess of the computed friction. It may be that the increased friction in the Attleboro and 30-in. Taunton line is due to tuberculation or deterioration of the inner surfaces of the pipe. This will not probably account for the greater increase in the 24-in. line. I know of no condition that should cause this increase over the 30-in. or the Attleboro line.

The dates of laying the pipe lines are as follows: Walpole, 1895; Ipswich, 1894; 24-in. Taunton main, 1893; 30-in. Taunton line, and Attleboro, 1892.

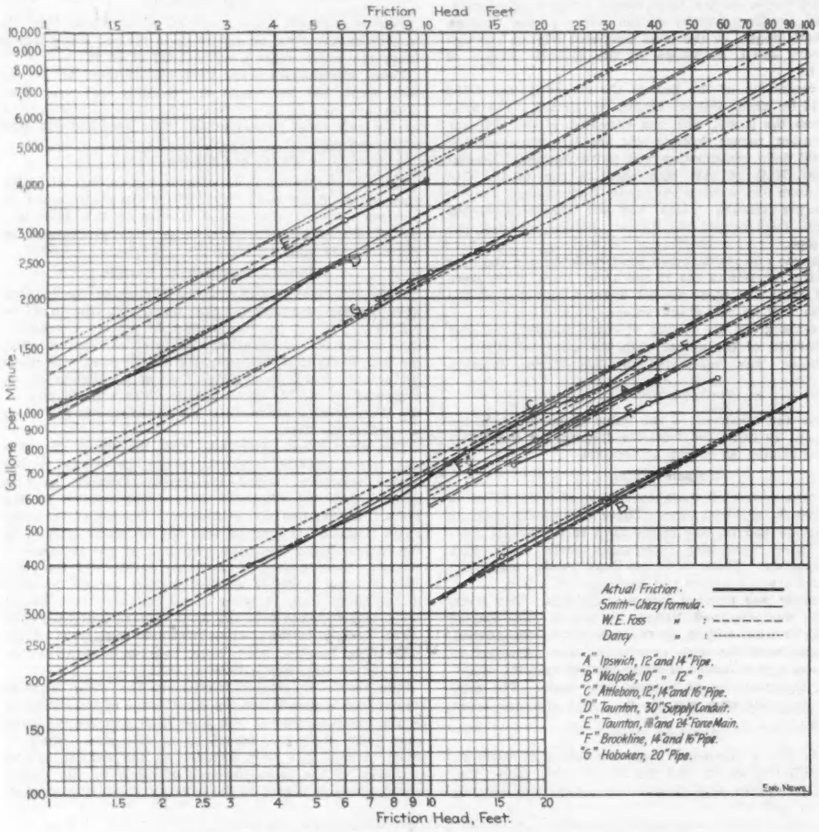
This result of greater friction in the older lines is interesting on account of the significance of the condition of the inner surface of the pipe lines and its influence upon their discharge, especially at this time, when so much interest has been aroused on the subject of the character of the inner surfaces of pipes by the recent developments in regard to the delivery of the riveted steel

Friction in a Number of Compound and Simple Cast Iron Pumping Mains of Various Diameters.

Test No.	Galls. per min	Vel., ft. per sec.	Computed friction, ft.	Galls. per min.	Vel., ft. per sec.	Computed friction, ft	Galls. per min.	Vel., ft. per sec.	Computed friction, ft	Total computed friction, ft	Actual friction, ft.	% computed to actual friction.
	Ipswich Main.											
	—9,060 ft. 12-in. pipe.—			—1,000 ft 12-in pipe—			—1,150 ft. 14-in pipe—			—11,210 ft. 12 and 14-in. pipe		
1.....	706	2.60	13.25	353	1.00	0.41	664	1.38	0.71	14.37	12.85	111.0
2.....	860	2.44	19.00	430	1.22	0.60	818	1.70	1.05	20.65	19.55	100.5
3.....	1,020	2.90	26.00	510	1.45	0.81	978	2.04	1.45	28.26	27.10	104.0
4.....	1,250	3.55	37.40	625	1.77	1.18	1,208	2.52	2.15	40.33	40.30	100.0
	Walpole Main.											
	—6,950 ft. 12-in. pipe—			—8,900 ft. 10-in. pipe—						—15,750 ft. 12 and 10-in. pipe.		
1.....	334	0.95	2.61	....	1.36	8.17	....	....	....	10.78	10.93	99.0
2.....	471	1.20	4.10	....	1.68	12.45	....	....	....	16.55	15.55	106.5
3.....	585	1.66	7.30	....	2.40	22.45	....	....	....	29.75	28.80	103.3
4.....	704	2.00	10.15	....	2.88	31.35	....	....	....	41.50	40.30	103.0
5.....	792	2.25	12.60	....	3.24	38.90	....	....	....	51.50	51.80	99.5
	Attleboro Main.											
	—6,400 ft. 16-in. pipe—			—10,750 ft. 14-in. pipe—			—375 ft. 12-in. pipe—			—17,525 ft. 16. 14 and 12-in. pipe.		
1.....	402	0.64	0.85	452	0.84	2.80	....	....	....	3.65	3.37	108.0
2.....	603	0.97	1.76	603	1.25	5.77	203	0.57	0.06	7.59	8.25	92.0
3.....	796	1.27	2.90	796	1.61	9.40	396	1.12	0.19	12.49	12.62	99.0
4.....	943	1.57	3.96	943	1.96	12.75	543	1.54	0.34	17.15	17.25	99.5
5.....	1,052	1.68	4.80	1,052	2.19	15.40	652	1.85	0.47	20.72	21.75	95.5
6.....	1,083	1.73	5.08	1,083	2.26	16.40	683	1.94	0.51	21.99	24.00	91.7
7.....	1,177	1.88	5.84	1,177	2.45	19.00	777	2.20	0.65	25.49	29.00	88.0
8.....	1,354	2.17	7.52	1,354	2.82	24.30	945	2.68	0.96	32.78	35.50	92.5
9.....	1,392	2.23	7.85	1,392	2.90	25.50	992	2.84	1.14	34.39	37.00	93.0
	Taunton Supply Conduit, 36,700 ft. 30-in. Pipe.											
1.....	1,033	0.47	1.15	....	....	....	....	....	....	....	1.0	115.0
2.....	1,610	0.72	2.55	....	....	....	....	....	....	....	3.0	85.2
3.....	1,969	0.892	3.70	....	....	....	....	....	....	....	4.0	92.5
4.....	2,300	1.045	4.80	....	....	....	....	....	....	....	5.0	96.0
5.....	2,530	1.15	5.90	....	....	....	....	....	....	....	6.0	98.5
	Taunton Main.											
	—6,000 ft. 24-in. pipe—			—50 ft. 18-in. pipe—						—6,050 ft. 24 and 18-in pipe.		
1.....	4,096	2.91	7.90	4,096	5.12	0.24	....	....	....	7.24	9.87	73.50
2.....	3,693	2.55	5.80	3,693	4.42	0.20	....	....	....	6.00	8.13	73.80
3.....	3,228	2.29	4.53	3,228	4.04	0.15	....	....	....	4.68	6.13	76.50
4.....	2,785	1.97	3.50	2,785	3.48	0.12	....	....	....	3.62	4.75	76.30
5.....	2,220	1.57	2.30	2,220	2.77	0.10	....	....	....	2.40	3.13	77.20

pipe line of the East Jersey Water Co. It is well known that the roughness of the pipe is an important element, but the degree to which it affects the delivery has not been determined, and it may be that enough consideration has not generally been given to it in designing pipe lines and systems.

Mr. Desmond Fitz Gerald, in a paper recently read before the American Society of Civil Engineers, shows that in a 48-in. coated cast iron pipe the removal of the tuberculation of 18 years' growth caused an increase of 30 % in the discharge of the pipe. This would be equal to a reduction of about 23 % in the discharge of clean pipes caused by that degree of tuberculation, or an increase of the frictional head of about 50 %. This conclusively shows that the effect of tuberculation is no slight matter, and although it is not possible at present to give such effect a definite value for any age or


Friction Head Feet
Gallons per Minute.
Friction Head, Feet.
Actual Friction
Smith-Chezy Formula
W. E. Foss "
Darcy "
"A" Ipswich, 12" and 14" Pipe.
"B" Walpole, 10" " 12" "
"C" Attleboro, 12", 14" and 16" Pipe.
"D" Taunton, 30" Supply Conduit.
"E" Taunton, 18" and 24" Force Main.
"F" Brookline, 14" and 16" Pipe.
"G" Hoboken, 20" Pipe.
Eng. News.

COMPUTED AND ACTUAL FRICTION IN SEVERAL PUMPING MAINS.

By Freeman C. Coffin, M. Am. Soc. C. E.

condition of pipe, the fact should be emphasized that it is necessary to allow a wide margin for the increase of friction, or in other words, the decrease in delivery, unless it is intended to clean the pipes, or lay future supplementary lines.

I consider that the results of the experiments described in this paper indicate that it is safe, in the sizes experimented upon, to use the formula and coefficients mentioned for new pipe lines of coated cast iron pipe; that they also indicate a reduction of the capacity of a pipe line with age, and that this reduction commences in a slight degree in a very few years.

Graphic Comparison of Results.

The diagram shows the results of these experiments, plotted on logarithmic cross-section paper, and also the theoretical results in clean, straight pipes. The results of three different formulas are shown in each case by as many different kinds of lines.

The actual results are shown by a heavy full line. Those obtained by the Chezy formula with Smith's coefficient are shown by a light, full line. Those by a formula proposed by W. E. Foss, by a light broken line. The Foss formula is a most convenient one. It was proposed and its derivation described by Mr. W. E. Foss, in a paper read before the Boston Society of Civil Engineers, in 1894, and published in the "Journal of the Association of Engineering Societies" for June, 1894. The results of this formula nearly coincide with those of the Smith-Chezy formula, and it deserves especial mention on account of its extreme simplicity. According to Mr. Foss' nomenclature it is:

$$I = C^1 Q^{1\frac{1}{6}},$$

when I=friction head per foot, Q=discharge in cubic feet per second, and C^1=a coefficient, a table of which he gives for different diameters. He also gives a table of 11-6 powers. The third formula is that of Darcy for clean, straight pipes. This is represented by a light dotted line. The results for these three formulas for these sizes of pipes and for ordinary velocities do not differ materially.

Besides the experiments described above, the results of a series by Mr. F. F. Forbes upon a compound pipe in Brookline, consisting of 9,070 ft. of 14, and 16,250 ft. of 16-in. pipe are plotted. A description of these experiments was read before this association by Mr. Forbes in 1892. The pipe had been laid 18 years. The actual friction was 25 % greater than that computed by Smith's coefficients at the lowest velocity and 70 % greater at the highest.

The results of a series of experiments on a 20-in. pipe line, used as a pumping main for the city of Hoboken, and described by Mr. Chas. B. Brush, in the "Transactions of the American Society of Civil Engineers," in 1888, are also plotted. This was a simple main, 75,000 ft. long. It had been laid five years. The proportional results in 10,000 ft., instead of the total length, are plotted, so that the curve would not interfere with those of the other experimnts on the sheet. The friction in this case does not exceed the computed friction, except in the highest velocities. It will be seen that in all of the experimnts, with the possible exception of the 30-in. Taunton pipe, the actual friction increases faster with higher velocities than the computed friction, either by the Smith or the Foss formula, which are both practically formulas of the 11-6 or 1.83 power. The actual friction curve is nearer in direction if not in amount to the Darcy formula, which is one of the second power. The Brookline curve is greater still, or one of the 2.35 power. It is probable that greater roughness tends to even higher values of the exponent.

I believe this increase in the exponent in the new pipes of Ipswich and Walpole (which, while it was evident, was not so marked as in the older lines) was caused by the presence of gates and specials in the line, and that if the velocities had been carried higher, the increase would have been still greater.

A bill to create a board of civil engineers and to require the licensing of persons who desire to practice engineering and surveying, has been introduced in the Mississippi House of Representatives by Mr. Judson Russell, of Meridian, Miss.

CONCRETE LOCKS ON THE COOSA RIVER, ALABAMA.

By Charles Firth, U. S. Asst. Engineer.

(With inset.)

That portion of the Coosa River in Alabama now being canalized by the United States Government consists of a stretch of 116 miles, flowing through a rough rocky country, practically devoid of agriculture throughout the greater part of the distance, but reputed to be rich in minerals, especially coal and iron. Above this section is a navigable river of 293 miles, reaching into northwest Georgia, while below it the Alabama river of 367 miles is navigable to the Gulf of Mexico, at Mobile. Both of these portions are used by lines of steamboats making regular trips at all seasons. The opening up of the obstructed section will therefore give a continuous waterway of 776 miles, and afford cheap transportation to the Gulf for the large deposits of coal and iron undoubtedly existing in the country drained by the river and its tributaries.

On the upper end of this section of river now undergoing improvement, the locks, three of which are built and in operation, are constructed of limestone masonry, a first-class quality of blue limestone being abundant on the banks of the river; but on the lower end the rock is metamorphic, consisting of mica schist enclosing boulders of quartz and a heavy solid stone resembling whinstone. It was therefore considered advisable to construct the locks at this end entirely of concrete, with the exception of the hollow quoins and a few special stones; these are of Georgia granite.

Owing to the frequent and excessive floods at this point, which have been known to rise to a height of 60 ft. above low water level (an illustration of an average rise is shown in Fig. 2), it became advisable to have the concrete mixing plant above reach of all but extraordinary floods. A very complete plant, which was described in Engineering News of Oct. 31, 1895, was therefore erected on the river bank. The concrete cars were lowered into the lock-pit by an elevator controlled by a friction drum, the exit from the elevator being raised from time to time as the building up of the walls progressed. The stone used was procured from the channel excavation a short distance above the lock, and passed through a No. 3 Gates crusher; the sand was pumped up from the bed of the river below the lock. Fig. 4 shows the concrete mixer used on the work.

Lock No. 31, which is shown in the illustrations, has a length of 322 ft. between hollow quoins, and 420 ft. over all, with a width in the clear of 52 ft.; the lift is 14.7 ft., and the depth over the sills at extreme low water is 8 ft. The walls are 34.7 ft. in height above the level of the lower sill, by 16 ft. thick at their base. The total quantity of concrete used has been about 20,000 cu. yds. Three brands of Portland cement were used, 10,000 barrels of Atlas, 10,000 of Alsen's White Label, and 1,500 of Gibb's Double Ground.

The proportions of the concrete were 1 part cement, 3 parts sand and 5½ parts of crushed stone. Each charge for the mixers consisted of 3 cu. ft. of cement, 9 cu. ft. of sand and 16.5 cu. ft. of crushed stone; this was turned over four times before and six times after the water was added, at a speed not exceeding eight revolutions per minute. On being dumped into the cars the charge measured 24 cu. ft., and it required 34 cu. ft., measured in the cars, to make 1 cu. yd. of concrete rammed in place. The quantity of water used varied with the temperature and the state of the weather. The object desired was to have no water show in the concrete until ramming brought it to the surface, but the tendency was for the foremen to get it wetter than was necessary, as that facilitated the labor of packing it around stones and molds. The concrete was generally rammed in 6 to 8-in. layers. For all exposed surfaces of the work a different mixture was used, consisting of 1 part of cement to 3 parts of screened sand. This was brought up simultaneously with the backing contiguous to it; 2 × 12-in. planks were placed 4 ins. from the face of the molds, being held apart from them by 2 × 4-in. strips. After the backing was put in

and partially rammed, these planks were withdrawn, and the mortar was packed into the space thus left; the ramming was then completed. Concrete already set was always washed down and covered liberally with cement grout before new concrete was placed on top of it. The backs of all stones embedded in the work were treated in the same way.

The walls were carried up in lifts, each lift being completed all round the lock and wing walls before the next was commenced. The first lift was 10.7 ft. in height, and each succeeding one 6 ft., except the top one, which was 4.5 ft., exclusive of the 18-in. coping. Fig. 2 shows the first lift when nearing completion, only that portion round the upper gateway remaining to be done.

The coping, 5 ft. wide, was laid separately in blocks, which were cast in molds during seasons of high water, when work on the lock was interrupted. The bulk of the concrete in the coping blocks was of the proportions of 1 of cement to 2 of sand and 3 of broken stone, having a mortar face of cement and screened sand in equal proportions; the blocks, which were 5 × 3 × 1.5 ft., were cast face down; the lock edge of the land wall and both edges of the river wall blocks were rounded to a 3-in. radius and a slope of 1 in. was given towards the lock. The sides of the block molds were removed three days after filling, and the blocks were lifted about ten days later and stacked away.

The manner of constructing the molds for the lock walls was simple; 6 × 8-in. posts, 24 ft. long, with true faces, were set up in line 3 ins. from the face of the wall inside of the lock, and 5 ft. 7 ins. apart, and a similar row of posts, 12 ft. long, was set 3 ins. from the back of the wall; these rows were fastened together at the top of the shorter posts with 6 × 8-in. caps, which held them the proper distance apart and supported the track stringers for the concrete cars; each line of posts was well braced from behind and the walls were sheeted with 3 × 10-in. plank, dressed true on both faces and edges. After the first lift was completed, the back row of posts was lifted onto the offset left on the back of the wall by the reduced width of the next lift, and the caps moved up on the front posts; the sheeting was also moved up another lift. When the walls got too high for the posts to be braced from the ground, a somewhat more elaborate system of bracing had to be adopted, but no bolts were built into the walls, as this was thought to be undesirable if it could be avoided.

The concrete cars were of the bottom-dump pattern and dropped their loads into the middle of the wall onto large square boards placed underneath, as it was found that even with the smallest drop there was a tendency for the larger and heavier portions of the stone to separate from the mass and come to the edges; the boards facilitated shovelling, and the stones that came to the edges were thrown back onto the centre of the heap before it was removed and spread; the boards were moved as the work advanced. The shovellers were followed by the rammers, using iron rammers of 30 lbs. weight, with 6 in. square faces, who rammed the concrete until the water showed on top.

The doors of the dump-cars were hung at the sides, which proved to be an objectionable feature, as when dumping, they would strike the stringers carrying the track and the jar would be transmitted to the faces of the molds, necessitating unceasing attention in order to keep them in true line. A better method would have been to hinge the doors at each end, opening in the middle. Each half would then swing clear, and, unless the car was stopped very close to a cap, they would not strike anything. It was also found advisable in the progress of the work to allow for plenty of head room at the close of a lift, as otherwise the shovelling and ramming was not satisfactorily done.

A great source of delay and expense was the constantly recurring floods which would come with very little warning, notwithstanding a careful study of the weather map, when every structure and every piece of timber had to be weighted or securely fastened down; no small matter where such large quantities of timber were used, and as was frequently the case, the river rose during the night. During the year ending June 30, 1895, there were only 90 days on which work on the lock itself could be carried on undisturbed by high water. A double cause can be assigned to the excessive floods at this point: first, the river for 50 miles above this site has an average fall of 5.1 ft. per mile, with a fairly straight course, while below, for the remaining 367 miles of its length, its average fall is not more than 4 ins. per mile, with a very tortuous course, thereby preventing the water from getting away as rapidly as it came down the steeper section. In addition to this, another river, the Tallapoosa, having about the same discharge, joins the Coosa 11 miles below the site of the lock. The sources of the two rivers are wide apart, but a heavy rainfall in either district drowned out the lock; the Tallapoosa having been known to rise 25 ft., while the Coosa rose but 6 ins., and vice versa.

No detailed figures of the cost of the work for this year have yet been prepared, but up to the close of the fiscal year ending June 30, 1895, the total quantity of concrete in place was 8,710 cu. yds., and the cost of the same, exclusive of any charge for the use of plant and tools, but inclusive of charges for engineering and superintendence, was as follows:

Cement, 8,679 barrels, at $2.48 4-10	$21,558.63
Broken stone, 7,672 cu.yds., at 76 cts.	5,830.72
Sand 3,124 " " 34 "	1,062.16
Mixing, depositing and ramming, 8,710 cu. yds., at 88 4-10 cts.	7,699.64
Staging and moulds	3,685.07
Total	$39,836.22

This gives an average cost per cu. yd. of $4.57 3-10; the original estimate was $5.61. The laborers are all negroes, the usual rate of wages being $1 per day of eight hours. Concreting was commenced in Sept., 1894, and was practically completed in November, 1895. The work was designed and carried out by the writer, under the direction of Major F. A. Mahan, Corps of Engineers, U. S. A.

REPORT ON IMPROVED WATER SUPPLY AND SEWERAGE SYSTEMS FOR CLEVELAND.

A report on improvements in the water supply of Cleveland, the disposal of its sewage, and flushing works for the Cuyahoga River has been made by Messrs. Rudolph Hering, G. H. Benzenberg and Desmond FitzGerald and approved, subject to some changes, by Messrs. M. E. Rawson, Chief City Engineer, and M. W. Kingsley, Superintendent of Water-Works.

The water supply is first taken up. The present supply is drawn from the lake through two tunnels connected with a crib about 1.2 miles from the shore, the pumping station being over ¼ mile inland and the tunnels extending to it. One of the tunnels is 5 × 5 1-6 ft., and 9,160 ft. long; the other is 7 × 7 1-6 ft., and 9,080 ft. in length. As the pumps draw water from brick conduits above the level of the tunnels, being connected by shafts, it is therefore impossible to so lower the water in the shore end of the tunnels as to produce the maximum safeworking velocity of tunnel flow. The latter is assumed as about 4 ft. per sec., which would give 150,000,000 gallons a day. The present arrangement will give only a little more than half this amount. Besides recommending an additional pumping capacity of 30,000,000 gallons a day, it is advised that the pumps be so placed that the water in the wells may be lowered to a point not less than 20 ft. below the lowest lake level.

The present population of Cleveland is given in the report as not over 350,000. (It was 160,000 in 1880 and only 260,000 in 1890.) The average daily consumption is now about 43,000,000 gallons, and the maximum, 65,000,000 gallons a day. A supply of 150,000,000 gallons a day should therefore be sufficient for many years to come.

But while the quantity would be assured by making the improvements recommended, they would have no effect upon the quality of the water supplied. Without going into detail, it may be stated that the report shows that the intake should be located farther from shore, even with the change in the sewer outlets hereafter recommended. A point four miles from the pumping station, or some 3¾ miles from shore, in 53 ft. of water, is designated as a proper location for a new intake. It is thought that an 8-ft. brick-lined tunnel would be equivalent in capacity to the existing tunnels, so that it would only be necessary to build such a tunnel from the present intake to the proposed intake.

Cast iron mains sunk in the bed of the lake, the experts consider, would be more expensive than a tunnel of the same capacity.

A submerged intake crib is recommended for the following reasons:

> We have considered the form of the intake at the terminus of the new extension, and we firmly believe that a submerged crib should be adopted. Where a crib is designed to extend above the surface of the lake for the purpose of giving access to the tunnel and to draw water at different levels, it must be of most substantial construction. Small and weak cribs have proved a constant source of anxiety and expense and even where a very large structure is used, surmounted by heavy masonry walls, it acts as an obstacle to the free passage of ice, which in consequence piles up in great masses and to considerable depths, interfering with the free access of water to the ports. Such a structure entails heavy expenditure, both in original construction and maintenance. It is an impediment to navigation and must be supplied with a lighthouse.
>
> A submerged crib, on the other hand, say 10 ft. in height, in 53 ft. of water, allows the free passage of ice on the surface, and uninterrupted access for the water. In a lake the size of Lake Erie stagnation effects could hardly occur in such a position and the water will always be of excellent quality near the bottom. We, therefore, recommend a submerged crib for the intake.
>
> It is important that the velocity of the water, when it enters the crib, should be reduced to but 3 or 4 ins. per sec., and that the area of ingress be sufficient to produce this result. The evident consequence will be that less floating matter will be drawn into the crib.

As to the advisability of filtering the present supply, instead of extending the tunnel, the following most pertinent remarks are made:

> If the water at the source were polluted, with no way of stopping the pollution, filtration would be necessary at whatever cost. Until brought within proper limits, however, the extravagant water consumption in American cities and towns, constituting as it does an abuse rather than a reasonable use of water, must prove a most serious obstacle to the furnishing of a purer supply by filtration in at least a majority of instances.
>
> Questions of quantity and quality are more intimately related than is generally supposed. To provide and maintain a proper filtering plant for the city of Cleveland, looking forward twenty years at the present rate of increase in consumption, would entail a very large cost.
>
> Under the conditions found at Cleveland we do not think it advisable for the city to undertake filtration, believing that an excellent supply can be secured at much less cost.

Attention is called to the presence of garbage along the lake front and the urgent necessity of devising some other means of disposal than dumping in the lake.

As to sewage disposal, it is considered possible to remove the sewage so far from the water intake as to avoid all chances of pollution, and that this can be effected at less cost than would be necessary if purification were adopted. The high price of land along the lake shore would prohibit land disposal there and necessitate pumping the sewage inland, while chemical precipitation would only partially purify the sewage, and that at an estimated cost of 30 cts. per capita per year, aside from capital charges. It is recommended that the sewage be discharged ten miles from the intake, measured along the shore. This necessitates high and low level intercepting sewers, with pumping for some districts. It is assumed that provision should be made for 20 cu. ft. (150 gallons) of sewage per inhabitant per day for a population of 1,000,000, with a maximum flow of 26 to 28 ft.; also that the first surface wash from rainstorms and all the yield of slight rains should be carried by the interceptors, raising their capacity per inhabitant to 54 cu. ft., or about 400 gallons per day, or a total of 400,000,000 gallons.

A fall of 2 ft. per mile was assumed as the proper grade for the sewer and a diameter of 13 ft., both at the lower end, the fall increasing and the diameter decreasing towards the city end. This is designed to give a velocity of 4 ft. per sec. A main pumping station, with auxiliary lifts by means of shore ejectors or electric pumps is proposed for the low level sewage.

The system is designed to exclude all house sewage and manufacturing wastes from the Cuyahoga River, which is now badly polluted. The separate system of sewerage is recommended for the portion of the city where pumping will be necessary.

The final section of the report relates to the

purification of the Cuyahoga River. This stream has a drainage area of nearly 1,000 sq. miles, and divides the city into two nearly equal parts. The lower five miles of the river is very circuitous. Its condition and the need for purification are clearly set forth in the report as follows:

Near its outlet it is quite circuitous, traversing a distance of five miles in reaching the mouth of the harbor, from a point not over 2½ miles distant. Along this distance of five miles, it is generaly docked and dredged, its banks are occupied by manufactories and other business enterprises and its average cross-section has an area of about 3,100 sq. ft. Notwithstanding the large area of the watershed tributary to the Cuyahoga River, its volume of dry weather flow is so small as to produce no perceptible current along its dredged channel. From gagings, taken south of the city, it is reported that this dry weather flow, during the months of June, July, August, September and October of this year, has not exceeded 83 cu. ft. per sec. This amount creates so slight a current towards the lake that even when not affected by any winds or changes in lake level, it takes nearly two weeks' time to displace the quantity of water between the southern city limits and the mouth of the harbor. Under the most favorable conditions, therefore, the river during these months is nothing more than an extremely sluggish stream. The current, however, is subject to influences from the lake and wind, and is therefore almost as frequently up-stream as it is down. The observations of the water levels made simultaneously at various points along the river and lake, clearly indicate that during the dry season the lower part of the river, so far as the currents are concerned, is but an arm of the lake, receiving the filth and refuse of a large city without having a current sufficient to clear itself. Along its lower five miles the river receives a portion of the sewage from 14 of the 22 sewerage districts into which the city is divided, populated by over 140,000 people. It also receives the factory refuse and waste from 17 slaughter houses and kindred establishments, from 12 breweries, 4 tanneries, 3 soap manufactories and 28 other works whose refuse or waste is equally effective in polluting the river.

The solids from this sewage and factory refuse, which has been pouring for years into the sluggish stream, sink to the bottom and form a sludge, which in warm weather becomes a powerful agent in still further polluting the river by putrefactive fermentation. This action becomes perceptible by the gas bubbles on the river surface, and by an offensive odor when the water, in time of drought, has become black in color and saturated with filth.

By collecting both by gravity and low-level intercepting sewers, as heretofore mentioned, all the sewage and factory refuse that is discharged into Walworth and Kingsbury runs and into the river, and by removing the same by gravity and by pumping to the outfall on the lake shore, the further discharge of such sewage and refuse into the river, between the points mentioned, will naturally be arrested.

The sludge, however, which has for years accumulated on the river bottom, filling up all depressions, as well as the spaces between the piling under the docks, remains to aid in polluting the almost stagnant river water during the summer months, when the temperature and conditions are favorable. This has not only been shown in cities where sewage and factory refuse has been discharged in stagnant or sluggish streams but has been in a measure demonstrated with samples of sludge taken from the bottom of the Cuyahoga River. If the river possessed a constant current sufficient to displace the water every 24 hours, from the Graselli Chemical Works (which is as far as the river is docked and dredged) down to the mouth of the harbor, the consequent dilution of the sewage and factory refuse remaining to be discharged into the river would be ample to maintain the river in a good, clear, and not only inoffensive, but pleasant condition. To accomplish this result would require a flow of about 916 cu. ft. per sec., and as the reported dry weather flow during the five months in the year does not exceed 83 cu. ft. per sec., the deficiency of 833 cu. ft. must be supplied in an artificial way.

The most practicable way of securing this flow, the report shows, is by pumping water into the river from the lake. Flushing with water stored in the watershed was considered, but the quantity required and a lack of available sites for reservoirs render this impracticable.

Regarding the dimensions of the tunnel, the report may best be quoted, as follows:

The general course of the river requires the tunnel to be three miles long. Much consideration has been given to the question of the proper diameter of the tunnel. In view of the great advantage arising from a low lift, especially for the class of machinery selected for the pumping plant, we recommend 18 ft. as a proper diameter for the tunnel. A tunnel of this size will be of greater permanent value for the city than one of smaller dimensions, especially in view of the fact that it may be desirable in the future, on account of the further growth and development of the city and of the manufacturing industries along the river, to increase the quantity of water to be delivered for flushing the river to 1,300 cu. ft. per sec. Computation demonstrates that in comparing the cost of a 16 and 18-ft. diameter tunnel, with the cost of pumping during the dry season, it is good economy for the city to adopt the larger size. With a delivery of 1,300 cu. ft. per sec. there would be a saving in the 18, as compared with the 16-ft. tunnel, of at least 800 HP. in the engines and of not less than 27 tons of coal for every 24 hours of pumping.

A screw wheel type of pump is recommended in the following language:

The most efficient, simple, and economical mechanism known, capable of discharging such immense volumes of water under comparatively low heads is the screw wheel, whose discharge per revolution, independent of its speed, seems to be almost as constant and uniform as that of a piston pump. Its capacity exceeds that of all other styles of pumps, while its economy for large volumes and low heads is greater than that of any wheel pump. It is therefore peculiarly well adapted for such work as herein proposed.

Messrs. Benzenberg and Fitz Gerald advise that the flushing tunnel be constructed at the same time as the other works, but Mr. Hering thinks it would be wise to await the results that will follow the completion and operation of the intercepting sewers. Mr. Rawson concurs with the majority and Mr. Kingsley with the minority in the matter of the date for constructing the flushing works. Mr. Kingsley also believes that a new and independent water-works tunnel and a pumping station on a new site should be constructed either simultaneously with or before the extension of the present tunnels. In other respects Messrs. Rawson and Kingsley concur in the report.

STANDARD 90-LB. RAIL; LEHIGH VALLEY R. R.

We illustrate this week the new rail section recently adopted by the Lehigh Valley R. R. as its standard, and the form of joint used therewith. This rail is made in lengths of 45 ft., with square cut ends instead of the miter cut ends, which were at one time in quite extensive use on the Lehigh Valley. On the rail section, Fig. 1, we have drawn the section of the 90-lb. rail as recommended by the committee of the American Society of Civil Engineers, and it will be noted that the Lehigh Valley R. R. rail is deficient in height and retains the objectionably heavy head of many older sections which form of head it is difficult to roll in such a way as to get as good a wearing quality of metal as in the smaller head now generally adopted. The flare of the sides of the head has been reduced from 10° to 5° in the new section. The general dimensions of the two sections are as follows:

Dimensions of 90-lb. Rails.

	L. V. R. R. ins.	Am. Soc. C. E. ins.
Height	5	5⅜
Width of base	5	5⅜
Width of head (maximum)	2⅜	2⅝
Side of head	Inc 5°	Vert.
Depth of head	1 53-64	1 19-32
Height of web	2 15-64	2 55-64
Depth of base	15-16	59-64
Thickness of web	⅝	9-16
Height to center of bolt hole	2 1-16	....
Radius of top of head	12	12
" of top corners of head	1/9	5-16
" of bottom corners of head	⅛	1-16
" of top fillets	¼	¼
" of bottom fillets	¼	¼
" of corners of base	1-16	1-16
" of sides of web	9	12
Fishing angles of head and base	14°	13°
Metal in head, per cent	47.8	42
" in web, "	18.2	21
" in base, "	34.0	37

The angle splice bars, Fig. 2, are of the well-known Sayre section, with exceptionally heavy flanges at top and bottom to give stiffness to the bar. They are 28 ins. long, weighing 55 lbs. per

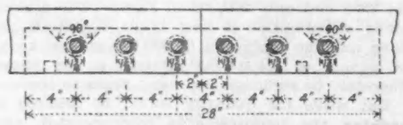


Fig. 2. Standard Joint for 90-lb. Rail; Lehigh Valley R. R.

yd., while the six bolts weigh 7¾ lbs., and the six nutlocks ½ lb. The bolts are ⅞-in. diameter, with oval necks, and are spaced uniformly 4 ins. c. to c. One splice bar has holes 15-16 in. diameter, and the other has holes 15-16 × 1 3-16 ins. With full contraction the maximum space between rail ends is ⅜-in. The track is laid with broken, suspended joints.

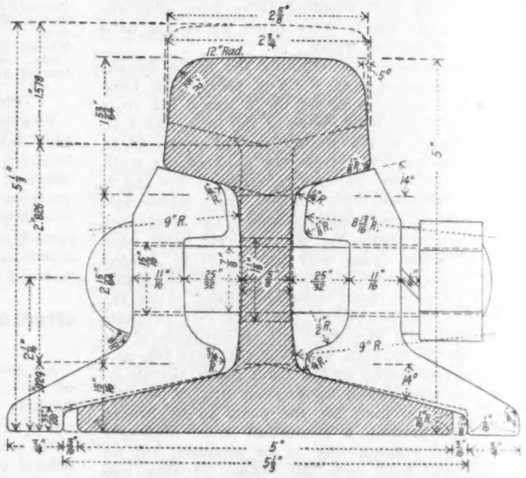


Fig. 1. New 90-lb. Rail Section for Rails 45 ft. long; Lehigh Valley R. R Am. Soc. C. E. 90-lb. Rail Section Shown by Dotted Lines

THE FINAL DISPOSITION OF THE WASTES OF NEW YORK CITY.

Advance sheets of a portion of a report on the disposal of the garbage, street sweepings, horse manure, store and other refuse of New York city have just been made public by Col. Geo. E. Waring, Jr., M. Inst. C. E., Commissioner of Street Cleaning. A large part of the credit for the information contained in the report is given by Col. Waring to his assistants, Messrs. Macdonough Craven, Hawthorne Hill and C. Herschel Koyl.

After referring to the present practice of dumping the garbage and other refuse of New York at sea as "wasteful and pernicious," Col. Waring lays down some principles pertaining to the final disposition of this matter, as follows:

It is known that garbage cannot be economically utilized if it is mixed with any considerable quantity of rubbish or ashes; it is known that it cannot be economically incinerated unless it is separated at least from the bulk of the ashes with which, under the prevailing New York practice, it is mixed; it is known that ashes cannot be used as a filling material so long as they contain such waste organic matters as constitute the garbage and some of the rubbish of city collections; it is also known that a very considerable part of garbage and rubbish, as collected throughout the city, is of sufficient value to pay more than the cost of its collection.

In March, 1895, informal bids were invited to determine the prices at which companies would be willing to dispose of the garbage of New York city. Of 26 companies responding, only one was willing to undertake to dispose of the garbage without pay from the city. The average of the prices named was 55 cts. per ton for utilization, and 90 cts. for cremation processes. The Department considered that only about half of the 26 bidders were "sufficiently experienced and responsible to make offers" which would be "acceptable to the city." Circular letters were sent to each of the companies proposing thorough examinations of their processes by competent men, the salaries of the men and all expenses incident to the tests to be paid by the companies. Several of the concerns agreed to this proposition, and a number of studies were made. It was agreed that the details of the investigations should be kept secret, so the report gives only a summary of conclusions. The plants studied were those using the Merz process, at Buffalo and St. Louis; the Arnold process, employed by the American Incinerating Co., at Philadelphia; the Holthaus, at Bridgeport, Conn., operated by the Bridgeport Utilization Co., and four or five other processes, as yet in an experimental stage.* Regarding methods of extracting grease, the re-

*The Merz process was described at length in our issue of Nov. 1, 1894, and the Arnold, as used for a time at Boston, in our issue for March 28, 1895.

port states that the hydro-carbon processes are more thorough than any other; that the acid processes, as a rule, do not give good results; that mechanical processes extract a fair percentage of the grease. As to tankage, or available fertilizing material, and regarding utilization systems in general, the average composition of garbage and its selling value after being subjected to reduction, the report says:

The tankage is of varying quality, according to the method used and the class of garbage handled. All reduction methods, properly conducted, can be made unobjectionable from the sanitary point of view. The faults seem to come from the want of experience in construction, for what has been found offensive in one plant has been so handled in another as to be entirely without offense.

* * * *

Three thousand tons of garbage, from different cities, treated by different methods, show a general average composition of:

	Per cent.	Lbs. per ton.
Rubbish	7	140
Water	71	1,420
Grease	2	40
Tankage	20	400
	100	2,000

The selling value of a ton of garbage when treated is:

Grease, 40 lbs., at 3 cts.	$1.20
Tankage, ammonia, 13 lbs., at 8 cts.	1.04
Phosphoric acid, 13 lbs., at 1 ct.	.13
Potash, 3 lbs., at 3½ cts.	.10
Total	$2.47

The quantity of garbage collected in pounds per day per capita in eight American cities is given as follows:

Buffalo	0.245	New Bedford	0.890
Boston	0.946	Cincinnati	0.566
Wilmington	0.805	Philadelphia	0.332
St. Louis	0.277	Lowell	0.408

The report contains extended studies regarding grease and tankage as marketable products, the general conclusions seeming to be that there will be a good demand for the grease and that the tankage can best be disposed of as such; that is, it would be better to sell the tankage to manufacturers of fertilizers than to attempt to make a finished product, ready for market. The reason for the latter conclusion is that the fertilizer trade seems to be in a somewhat unstable condition; that when sold direct to farmers long credits must be given; that fertilizer manufacturers might combine against a contractor who attempted to sell finished fertilizers from a large garbage plant, like one built for New York, but would welcome tankage for use as a fertilizer filler.

TABLE I.—Annual Rainfall on Long Island for the Years 1826 to 1895, Inclusive.

Maximum for year=58.92 ins. in 1859.
" " 3 months=23.60 ins. in 1867.
Minimum for year=32.00 ins. in 1864.
" " 3 months=1.96 ins. in 1894.

Year.	Ins. of rainfall for: June, July and August.	Whole year.	Year.	Ins. of rainfall for: June, July and August.	Whole year.
1826	20.12	44.89	1861	8.38	45.65
1827	12.73	48.27	1862	11.08	38.02
1828	8.25	45.14	1863	10.25	32.76
1829	10.57	48.54	1864	9.67	32.00
1830	12.66	53.47	1865	9 89	46.14
1831	10.20	42.52	1866	10.86	51.68
1832	12.19	43.54	1867	23 60	54.61
1833	12 18	44.68	1868	11 52	38.58
1834	12.69	39.47	1869	10 80	43 13
1835	11.22	38 02	1870	9.65	39.25
1836	13.36	44.89	1871	18.22	51.26
1837	9.58	34.66	1872	18.92	39 75
1838	8.83	41.11	1873	15.45	47.99
1839	11 50	42.90	1874	10 27	45 83
1840	6.71	35 95	1875	16 58	40.90
1841	12.91	52.12	1876	8.59	41.77
1842	15.28	47.04	1877	11.30	40.18
1843	19.47	50.19	1878	15 67	48.66
1844	12.61	38.07	1879	15.38	39 61
1845	8.85	32.14	1880	16 01	40 76
1846	10.97	45.00	1881	8.28	39.53
1847	10.49	33.93	1882	6.77	39 83
1848	9.19	33 41	1883	7 34	37.22
1849	6.91	32 47	1884	13.16	45.39
1850	14.39	48 38	1885	10.31	36.85
1851	9.08	40.82	1886	12.01	51.38
1852	13.51	47.74	1887	15 80	45.66
1853	17.38	52.44	1888	10.37	48.45
1854	4.70	47.68	1889	15 59	56 54
1855	14.00	51.75	1890	14.21	52.15
1856	7.88	32 71	1891	11.64	39.18
1857	14.75	48.27	1892	8.49	37.75
1858	13.17	43.23	1893	6.72	39.62
1859	16.85	58.92	1894	1.96	36 88
1860	11.89	37.65	1895	10.21	39.64
			Average.	11.88	43.16

From 1826 to 1865, inclusive, and years 1868, 1869 and 1872, records kept at Flatbush.
Years 1866 and 1867, records kept at Cooper Union and Deaf Mute Asylum, by Prof. Orran W. Morris, New York.
1870 to 1878, inclusive, record kept at Central Park, New York, with exception of year 1872.
1879 to 1895, both inclusive, record kept at Hempstead storage reservoir.

The report also contains a discussion of the junk trade, and its relation to garbage disposal.

Cremation is not taken up at length in the report, utilization evidently being considered the most promising field of investigation. For towns and small cities, the report states, cremation is the best means of garbage disposal.

The final report, we understand, will be an extended study of the matter under discussion. It promises to be a most valuable addition to the available information on this important subject.

REPORTS ON AN ADDITIONAL WATER SUPPLY FOR BROOKLYN, N. Y.

By an error in the make-up of the pages in last week's issue, three tables were omitted from our abstract of the report on an additional water supply for Brooklyn. These tables are presented herewith.

THE SIMPLON TUNNEL.

From the letter of a Swiss correspondent of the London "Times" the following notes are taken relating to the present status of the Simplon tunnel project:—An agreement between Italy and Switzerland was finally signed on Nov. 25, 1895, setting forth the general plans and conditions of construction and operation and guaranteeing subventions on both sides. A syndicate of very responsible contractors has made a definite offer to construct the tunnel for a fixed sum, and all that is now awaited is the subscription of $8,000,000 by private capital.

As definitely located, this tunnel line passes under Monte Leone, between Brigue, the present terminus of the Swiss railways in that section, and Isella, on the Italian railways. The tunnel would be 64,718 ft. long, and its highest point, in the line of the tunnel would be 2,312.4 ft. above sea level, with a down grade in each direction of 1 m. in 50 m. towards Brigue, and 1 m. in 143 m. towards Isella. The principal difficulty to be encountered in construction will be the high temperatures in the heart of the mountain, about 122° F. To overcome this difficulty it is proposed to drive two parallel tunnels, 55.76 ft. apart. The first tunnel would be completely finished so as to admit a single track line of standard gage; the second tunnel will serve as a gallery—which may later be enlarged to admit a second track—which will be connected with tunnel No. 1 by transverse galleries every 656 ft. These transverse galleries will be closed by doors; but the two galleries nearest the working head will be left open for the purpose of ventilation. It is expected that an air current will enter one of these two galleries and return to tunnel No. 1 by the other. In driving the advance cross galleries, air cooled by a spray of cold water will have to be forced into the heading by blowers. Brandt drills, operated by hydraulic power, will be used in perforating the gneiss rock in which the tunnel chiefly will lie. The hydraulic power stations will be fed by the Rhone, at Brigue, and by the Diveria, at Isella. A boring, about 2,300 ft. deep above the tunnel, will admit the water of the Steinenbach, and supply hydraulic power by natural pressure.

Extreme precautions will be taken to insure the health of the workmen. Special clothing must be used while working; to be put on before entering the tunnel, and to be changed in a covered building on leaving. They will also have to take a warm bath before passing into the cold mountain air.

The experts appointed by the Federal Council were Messrs. Francis Fox, C. J. Wagner and G. Colombo, and the suggestions as to working, health precautions, etc., are taken from their report. The project itself is being pushed by Brandt, Brandon & Co., of Hamburg, who constructed the Suram tunnel in the Caucasus, by Messrs. Locher, who were engaged in the building of the Mt. Pilatus railway, and Messrs. Sulzer Bros., of Winterthur, well-known builders of machinery. The contractors guarantee the installation of plant, and the completion of the first tunnel and the ventilating gallery for the fixed sum of $10,900,000, and the completion of a second track, by enlarging the gallery, for $3,000,000 more. When the tunnel is being operated, artificial ventilation will be established. Each train entering will automatically close the door of the tunnel and air currents will be forced into the tunnel by machinery to overcome and drive out the gases of combustion.

The advantages claimed for the Simplon tunnel as an international route are as follows:—The reduction of distance between Calais and Milan and much more favorable conditions of grade than prevail on the Mont Cenis and St. Gothard routes. The highest points in the three tunnels, above sea level, are:—

Mont Cenis	4,246.6 ft.
St. Gothard	3,787.1 ft.
Simplon	2,312.4 ft.

As the operation of the Simplon tunnel will entail certain alterations in the Swiss railway system, it is impossible to state, at the present moment, what economy will ultimately result from this reduction in grade.

We find no mention in the report of any proposition to operate the tunnel by electric locomotives. As this would practically solve at once the ventilation question, which appears to be giving the projectors so much trouble, and as the current could be furnished from Alpine streams at small cost, it seems certain that that system will eventually be adopted.

TABLE II.—Population and Daily Water Consumption of the City of Brooklyn, 1860 to 1895, Inclusive.

Year.	Population.	Population dependent on Ridgewood water supply. (1=1,000)	Average daily consumption Ridgewood water supply in gallons. Total. (1=1,000)	Per capita.
'60	266,714 N.	All	3,293	12.3
'61	272,350 E.	"	4,064	14 9
'62	278,106 E.	"	5,026	18.1
'63	283,983 E.	"	6,493	2 .9
'64	289,985 E.	"	8,104	27.9
'65	296,112 S.	"	9,231	31.2
'66	313 852 E.	"	10,907	34.8
'67	332,656 E.	"	12,351	37.1
'68	352,585 E.	"	15,709	44.6
'69	373,710 E.	"	17,629	47.2
'70	396 099 N.	"	18,654	47.1
'71	412,405 E.	"	19,350	46.9
'72	429,389 E.	"	24,714	52.9
'73	447,054 E.	"	24,875	55.6
'74	465,455 E.	"	24.754	53.2
'75	484,616 S.	"	27,150	56.0
'76	500,614 E.	"	28,169	56.2
'77	515,903 E.	"	30,345	58.8
'78	532,296 E.	"	30,506	57.3
'79	549,211 E.	"	32,912	59.9
'80	566,663 N.	"	30,744	54.3
'81	584,659 P.	"	32,721	56.0
'82	601,103 P.	"	34,622	57.6
'83	617,517 P.	"	36,148	58.5
'84	634,887 P.	"	38,880	61.2
'85	673,050 P.	"	43,378	64.5
'86	750,000 P.	728†	45,304	62.2
'87	765,000 P.	741†	46,278	62.4
'88	782 221 P.	756†	49,793	65.8
'89	852,457 P.	823†	52,196	63.4
'90	853,945 P.	823†	55,200	67.0
'91	880,780 P.	846†	58,082	68.6
'92	957,958 S.	919†	67,565	73.5
'93	1,003,781 P.	961†	75,822	78.9
'94	1,080,000 P.	996‡	76,057	76.3
'95	1,105,000 H.	1,013‡	80,124	79.0

N—National Census. S—State Census. P—Police Reports of 1894. E—Estimated. H—Health Department Estimate. †—Exclusive of 26th Ward. ‡—Exclusive of 26th, 29th, 30th and 31st Wards.

TABLE III.—Population, Average Daily Water Consumption and Consumption Per Capita for New York City, 1870 to 1895, Inclusive.

Year.	Population.	Average daily consumption, gallons. Total (1=1,000,000.)	Per capita.	Remarks.
'70	942,292 N.	77	82	Rate % of yearly increase in population.
'71	961,900 E.	79	82	
'72	981,500 E.	81	82.4	
'73	1,001 0-0 E.	88	88	1870-1875=2.08
'74	1,021,000 E.	92	90	1875-1880=2.99
'75	1,041,846 S.	95	91	1880-1890=3.56
'76	1,073,000 E.	90	84	1890-1894=1.96
'77	1,105,000 E.	89	81	1876-1895=2.86
'78	1,136,800 E.	93	82	
'79	1,171,700 E.	93	80	
'80	1,206,590 N.	93	77	
'81	1,249,550 E.	94	75.2	
'82	1,294,050 E.	94	73	
'83	1,340,100 E.	94	70	
'84	1,387,800 E.	97	70	Bronx River supply opened Sept 9.
'85	1,437,250 E.	105	73	
'86	1,488 400 E	109	73	
'87	1,541,400 E.	109	71	
'88	1,596,300 E.	113	71	
'89	1,653,150 E.	114	70	
'90	1,712,000 E.*	145	85	New aqueduct opened
'91	1,745,500 E.	165	95	July 15.
'92	1,779,600 E.	162	91	
'93	1,814,500 E.	174	96	
'94	1,850,000 E.*	183	99	
'95	1,886.000 E.	189	100	

N—National Census. S—State Census. E—Estimated. E*—Police Estimate † Figures furnished by Mr. Birdsall, Engineer in Charge of Croton Aqueduct.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes of standing advertisements must be in hand on Monday after noon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The proposed establishment of a new terminus for transatlantic steamships at Fort Pond Bay, on the eastern end of Long Island, is again brought before the public by the introduction of a bill in Congress to make of the proposed harbor a so-called "free port," according to a scheme which is described in some detail in a news note on another page. We discussed the advantages claimed by Mr. Austin Corbin for this port as a steamship terminus in our issue of Nov. 7, and have seen no reason to change our opinion, then expressed, that the saving in time of the transatlantic voyage, which was adduced as the chief merit of the proposed new port, would not suffice to attract to it either freight or passenger traffic.

The Providence "Journal," which reprinted our editorial comments, suggested that we were hardly fair to Mr. Corbin's scheme in not considering the advantages which he claimed for the port of Milford Haven in Wales, which he also proposed as an eastern terminus instead of Liverpool or Southampton. It appears to us, however, that it is entirely proper to consider separately the advantages of the respective ports on each side. If Milford Haven has the practical advantage which Mr. Corbin claims, it is entirely feasible for existing transatlantic steamship lines to adopt it in place of their present eastern terminal ports, without making any change of their port of departure on this side of the Atlantic. Also the advantages or disadvantages of the proposed Fort Pond harbor on this side are just as great whether the steamers land their passengers on the other side at their present ports or at Milford Haven.

Concerning the proposition to make a "free port" of the Fort Pond Bay harbor, it would seem that the scheme is worth a careful examination, although some features of it will be likely to arouse more or less opposition in Congress. If Mr. Corbin should succeed in establishing his proposed port and securing its relief from onerous customs and other restrictions, he may be able to attract to it no small amount of traffic. The "free port" feature, in fact, seems much more likely to attract trade than the mere shortening of the transatlantic voyage on which so much stress has been laid. If it were worth while to go to the eastern end of Long Island to shorten the journey to Europe, it would be still more worth while, apparently, for the great steamship lines to land their passengers at Boston and shorten still more materially the duration of the voyage.

The distribution of water by pipe lines from a central pumping station to locomotive water tanks scattered along the line of a railway, is a novelty which has recently been introduced on the Long Island R. R., and is described elsewhere in this issue. There are probably not many places where circumstances would warrant the distribution of water by pipe lines over the long distances which ordinarily separate locomotive water supply stations; but the installation on the Long Island R. R. is interesting, nevertheless, as an example of the expense which is justifiable in securing pure water for locomotive service. Few engineers, unless they are familiar with locomotive work, appreciate the very great expense of locomotive boiler repairs where bad feed water is used, compared with the expense of such repairs with pure water. On any railway operating a large number of locomotives, the annual cost of boiler repairs with bard water will pay the interest on a very large sum, and a heavy outlay to secure a purer water supply will frequently pay a handsome return.

But while this is undeniably true, it is also true that in the original construction of practically all American railways little attention or none at all was paid to the purity of the locomotive boiler supplies. Water tanks were put in where convenience dictated or where grades were favorable for a stop, and it was left to a later generation to discover the costliness of this method of procedure, and take steps to remedy it. Many railways have already done this, but many others go on paying the heavy bills of the boiler repair shop, year in and year out, without an effort to see whether any measures for the improvement of their water supply are feasible.

It is at least worth consideration whether in districts where bad water prevails, the establishment of a central station, either taking water from some source where a pure supply is to be found, or else purifying the water by chemical action, together with the distribution of that supply through small pipe lines to all water stations within feasible distance, may not in some cases prove an advantageous plan.

The effect of refrigerator car drippings in corroding railway track and bridges and the trucks and brake gear of these cars is a subject which is likely to receive much more attention in the future than in the past. A committee of the Central Railway Club of Buffalo has recently been investigating this subject and its conclusions were briefly stated in our report of the January meeting (Eng. News, Jan. 16); but the full report of the meeting, which we have just received, brings out much more forcibly the need of attention to this matter. The committee's information, collected from all the principal railways which handle refrigerator car traffic, showed that among the parts which were found to have suffered injury from this cause were bridge floor beams and lateral sway-braces, iron surface cattle guards, switches and frogs, pipe lines and other details of interlocking switches, rails, rail splices, bolts and nuts, iron decks on transfer boats, brake beams, brake beam hangers and safety chains. Solid metal floors on bridges are not mentioned, but would naturally suffer severely from the corrosive drippings. It is stated that on the Lehigh Valley the corrosion of a rail proceeded so far as to cause its fracture.

It also appears that many railways are going to considerable expense in the way of painting, tarring or otherwise protecting their structures, where material injury is noted from the action of drip, and thus far nothing whatever has been done in the way of compelling owners of refrigerator cars to abate the nuisance which they are creating. The committee points out, however, that it is perfectly practicable for builders of refrigerator cars to provide for the collection and storage of the drip until an opportunity is afforded to discharge it at division terminals. In view of these facts the railway companies will make a great mistake if they do not promptly take united measures to compel some adequate remedy for the trouble they are experiencing. It is folly to go on, spending large sums on special inspection, painting, repairs, etc., on account of an evil which could be permanently remedied by a few slight and inexpensive changes in refrigerator car construction. It is a foundation principle of the rules of freight car interchange that no car in a condition likely to do injury to the track or structures of a railway will be received by it. These rules are competent to stop a car with a flat wheel; they ought to be made sufficient to stop a car which scatters a corrosive liquid all along its journey, doing injury thereby to track, bridges and rolling stock.

The discussions before the various railway clubs of proposed amendments to the "Rules of Interchange," indicate that the radical change in these rules which was proposed at the annual convention of the M. C. B. Association a year ago, and which failed of adoption by a close vote, is likely to be brought up again this year, and with much better chances of success. We explained in detail in our issue of June 20, 1895, the influences which are at work to bring about greater dispatch and less red tape in the movement of cars, and need not go over the ground again. As well illustrating the sentiments of some leading railway officials upon this question, we extract the following quotation from remarks of Mr. John Mackenzie, Superintendent of Motive Power of the New York, Chicago and St. Louis R. R., at the January meeting of the New York Railroad Club.

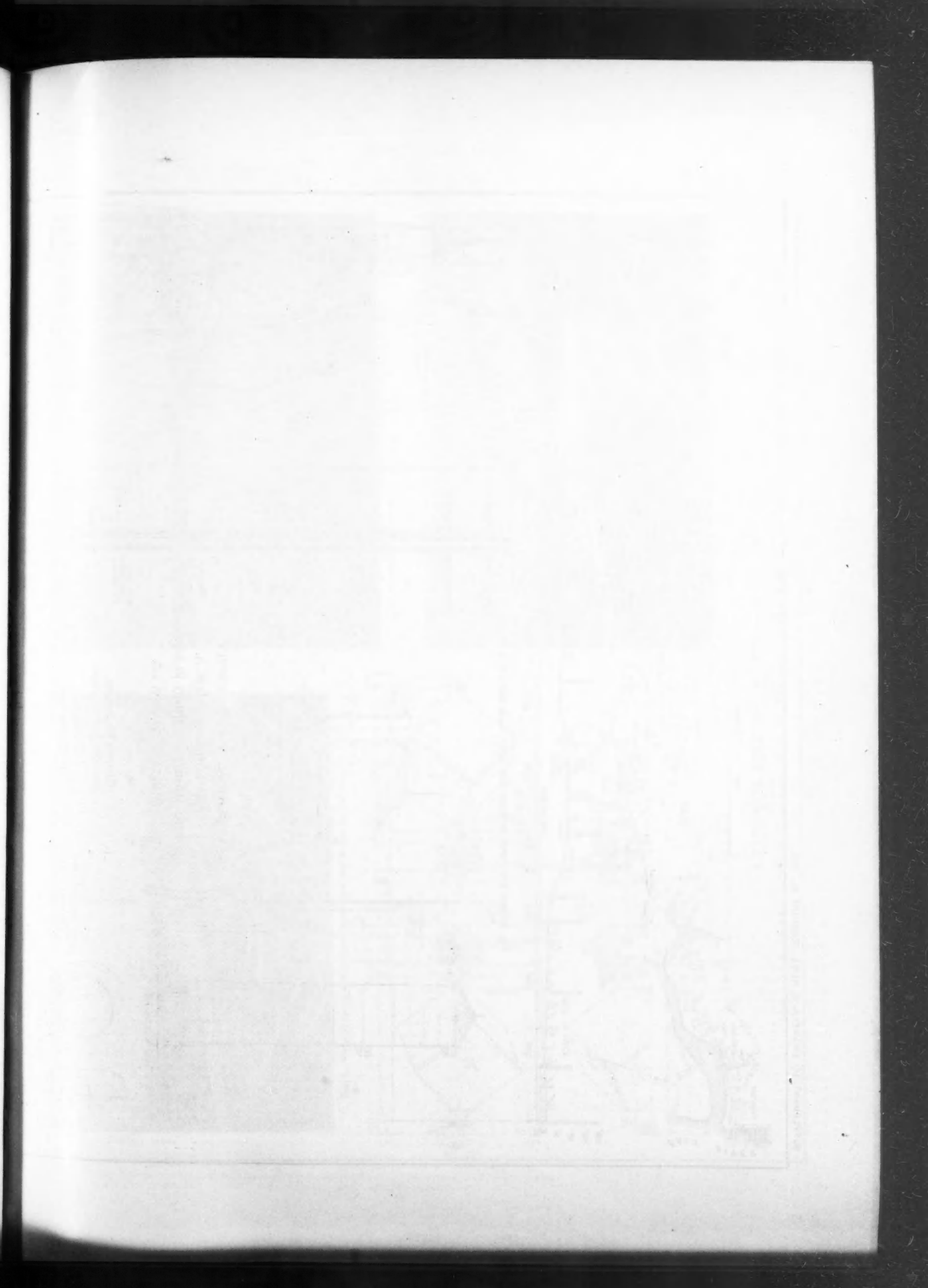
> The time has come when the transportation department has seen that there is such a thing as passing cars without objection. Cars can be moved and they can earn money, instead of waiting for somebody to make up his mind as to whether they shall put an I. O. U. on the car or not; and it lies with us whether we shall change the rules, and make them so simple and so positive in their operation, that the cars must move, rather than have them stand on the side tracks until a few men who are able to earn a dollar and a half a day shall wrangle and decide whether the car shall move or not. The transportation departments of this country have come to the conclusion that a smooth interchange can be introduced. The Chicago agreement has shown that it can be done. The mileage of the cars has been increased a very large percentage, and the time has come when we must either do something or they will take it out of our hands and let somebody else do it. The transportation departments are ready to-day to take hold and make an interchange that will move the cars of the country.
>
> What we want to say in our rules is that cars shall be offered in a serviceable condition, and they shall be accepted. Make the owners responsible for the defects that follow under fair usage. Under the Chicago agreement we undertake, with about thirteen different paragraphs, to cover the entire code of rules, and everything is working smoothly.

THE REORGANIZATION OF THE ENGINEER CORPS OF THE U. S. NAVY.

While the Squire bill, now pending in Congress, for the reorganization and increase of the Engineer Corps of the United States Navy is just now over-shadowed by financial legislation, its importance with respect to our national defences is probably not exceeded by that of any measure which will come before Congress at this session. Every one who has followed the recent history of the naval engineer corps is aware that the proposed increase in its numbers is an absolute necessity to properly and safely man the ships now in commission, to say nothing of the increase in their number which is currently proposed. It goes without saying that in increasing this branch of the naval service the best material available should be secured.

The chief features of the Squire bill have already been noted in this journal, and it is only necessary to repeat that they include the proper recognition of the officers of the engineer corps by some fixed form of relative rank, direct command of the enlisted men of the engineering department without interference by the line officers, an increase in the number of the corps, the admission to the corps of graduates from engineering schools, the establishment of an engineering experiment station, and, finally, the transfer to the engineer corps of certain duties now in the hands of line officers.

As to relative rank, all that the engineers appear to ask for is some designation which will remove all false outside impressions as to the relative position and responsibility of engineer officers as compared with line officers of equal rank and pay. The absolute control over the en-



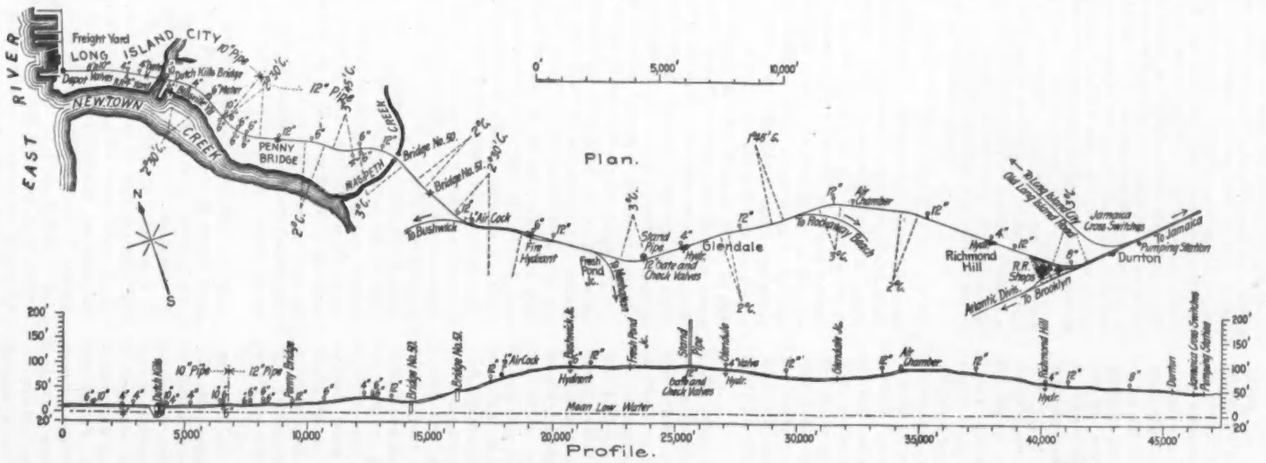
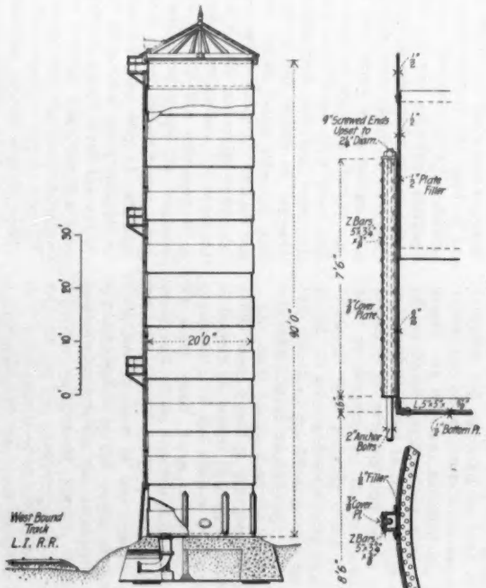
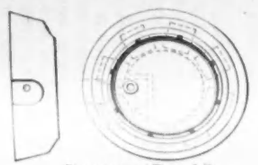


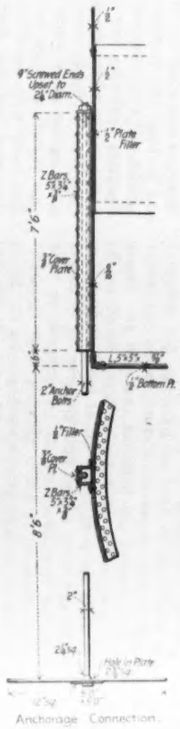
Fig. 3. Plan and Profile of Water Pipe Line · Long Island R. R.



Sectional Elevation.

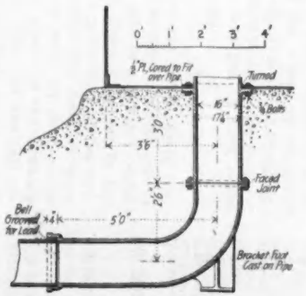


Elevation and Plan of Base.



Anchorage Connection.

Fig. 4. Details of Stand Pipe.

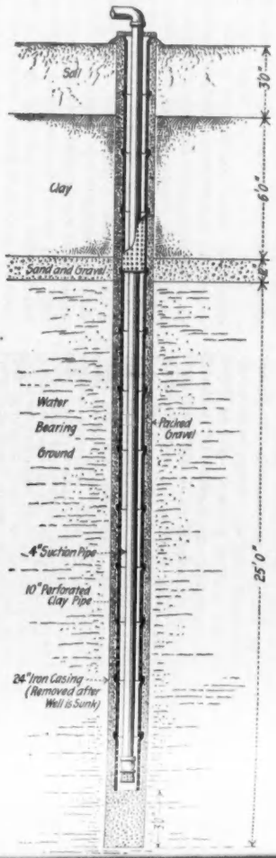


Details of Inlet Pipe.

CENTRAL WATER SUPPLY FOR LONG ISLAND R. R. AND MANUFACTURING PLANTS; MONTAUK WATER CO.

Charles M. Jacobs,
Consulting Engineer.

J. V. Davies,
Chief Engineer.



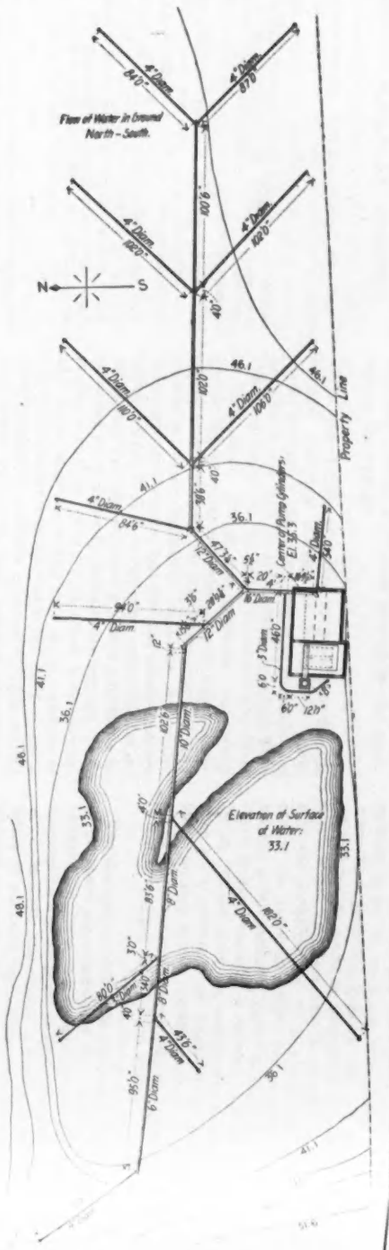


Fig. 2. Plan Showing Location of Wells.

Fig. 4. Details of Stand Pipe.

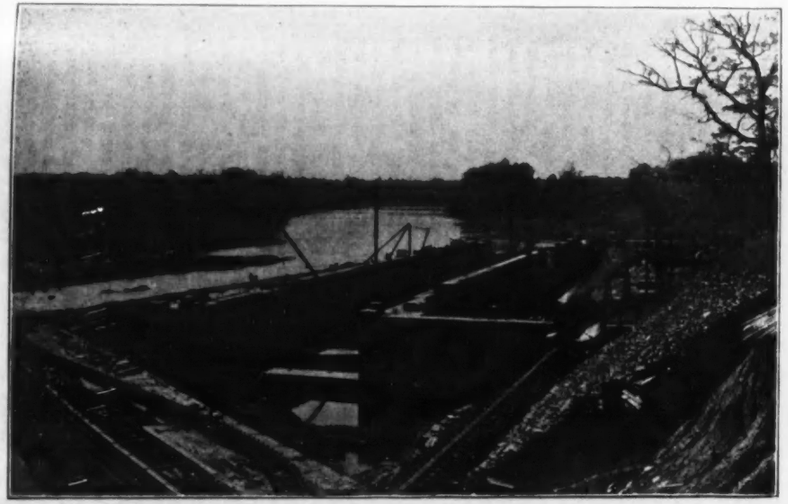


Fig. 1. View Showing Coffer-Dam Completed and Molds for Concrete in Place.

Fig. 2. Average High Water on the Coosa River. Point of View Same as in Fig. 1.

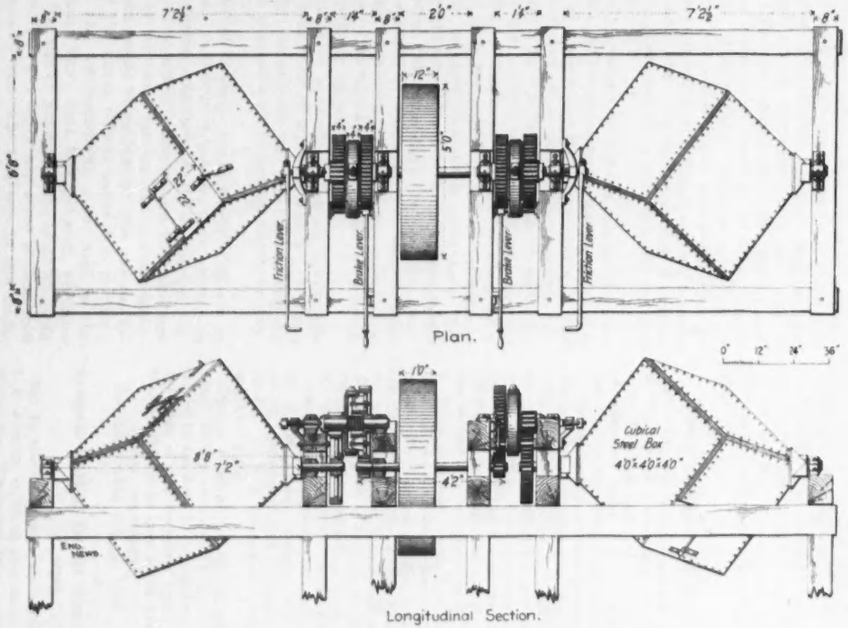


Fig. 4. Concrete Mixer Used on the Work.

Fig. 3. View of Lock Nearly Completed.

A CONCRETE LOCK ON THE COOSA RIVER, ALABAMA.

Major F. A. Mahan, Corps of Engineers, U. S. A., Engineer. Chas. Firth, U. S. Assistant Engineer in Charge.

listed men belonging to the engineering department is demanded in the interests of good discipline, and a change in this direction would remove one of the chief causes of present friction between the engineers and the line officers.

The thing most urgently needed, however, is an immediate increase in the number of engineers and the relief of the overworked members of the present staff. In this connection it is pointed out, between the lines of the bill, that the present practice in educating engineers and recruiting this corps solely from the Naval Academy is objectionable. The supply of engineer graduates is insufficient in numbers and is frequently lacking in quality. The cause for this lies deep-rooted in existing traditions and conditions prejudicial to the standing of the engineer corps, and consequently to the best interests of the service. For the first two years the cadets at Annapolis all stand upon a common footing, and it is not until the end of that period that a selection is made of those destined to become members of the steam engineering staff. It is then that the mischief begins. If any particularly bright young man shows a predilection for what may be termed the scientific course, every influence that his line associates and the line academic staff can bring to bear, social and otherwise, is exerted to discourage him from his choice. He is told that he will lose caste by becoming an engineer and "a greasy mechanic"; that he will always be at a disadvantage in messroom association and during his later professional career, etc. Unfortunately, this is but too true to a greater or less extent under an unwritten and obsolete tradition. It is this traditionary custom that the new bill seeks to destroy.

Under the existing practice of selection, appointment and education, an engineer officer of the U. S. Navy has quite as much right to rank as a "gentleman" as an officer in any other branch of the service. The existing demands of modern naval construction, maintenance and tactics are such that naval engineers, in order to efficiently perform all the many duties demanded of them, ought to be the most highly educated and scientifically trained officers of the service. To say that any man loses caste socially by entering this branch of the naval service is silly and unworthy of a sailor. The work of our engineer officers in the creation of our new navy has called forth the heartiest praise from the experts of all nations; and anything that tends to deteriorate the quality of future graduates from the Naval Academy, in the engineering branch, cannot be swept away too soon.

When our steam navy was young and no provision was made at the Academy for educataing engineers, the Government was obliged to recruit from private life the men required for this department. Among those who at that time entered the service there were some who were very likely better engineers than society leaders. But these men did noble and brave service, as the records of the department show, and it is not to the credit of the "gentlemen" graduates of the Naval Academy that they should have then begun to draw the invidious distinction between the line and the staff that has raged for 30 years and continues now, long after the inciting cause has ceased to exist.

By reason of this invidious distinction much harm has resulted to the naval service by driving from its lists and into civil life some of the best engineer officers it ever contained. The majority, if not all of these men, came originally from civil life, and among them were graduates of the Rensselaer Polytechnic Institute and other technical schools. This fact, coupled with the distinction attained by these former naval engineers, is the best argument that can be urged for the provision in the Squire bill proposing to obtain at least a part of the engineers now needed from a similar source. The character of the men thus lost to our navy can be measured by mentioning a few names from a long list of eminent consulting engineers, teachers in prominent colleges and heads of engineering enterprises. Among these ex-members of the naval engineering staff are such men as Charles H. Haswell, the late Charles W. Copeland, E. D. Leavitt, Robert H. Thurston, and W. F. Durand, of Cornell; Ira N. Hollis, of the Lawrence Scientific School; H. W. Spangler, of the University of Pennsylvania; M. E. Cooley, of the University of Michigan; David M. Greene, for many years President of Rensselaer Polytechnic Institute; George Westinghouse, Jr., Theodore Cooper, Nathan P. Towne, Charles E. Emery, F. B. Allen, Frederick K. Hain, of the Manhattan Elevated Ry., and many others of similar prominence now recalled. Our new navy depends for its efficiency upon the correct design of its intricate maze of operating and fighting machinery, and its constant supervision and maintenance. It needs in its daily service just such men as are named above. They once were members of its staff, and many of them would probably have been there still had the true value of their services and their actual merit as men been properly recognized.

The conditions under which these now eminent engineers entered the naval service should be restored, for the result fully justified the method of selection. The navy cannot afford to continue to take its engineers from cadet graduates who are not deemed worthy of being line officers, but "are good enough for engineers." Fresh, vigorous blood is wanted in this corps, and this can best be secured by recruiting that branch of the service largely from the graduates of technical schools. These new men would enter the service because of personal inclination and special training and fitness; they would enter the service uncontaminated by false ideas of caste, and would be prepared to command the respect and recognition due to their ability and attainments. Through them we could have our navy maintained and developed by the same class of men, now rapidly passing away, who made it what it is in all that pertains to its engineering department.

The proposed engineering experiment school is also a commendable feature. Contrary to the expectation and against the advice of doubting legislators of ten years ago, American ships and engines are not simply copies of what has been built in older navies. The efforts of our engineers in the direction of improvement upon older practice, and our triple-screw cruisers and the many innovations introduced into our ships now furnish models for foreign experts. But the best and safest aid to development of this sort is careful, elaborate experiment, and without this aid future progress is likely to be slow, and is necessarily attended with more or less risk of failure and loss. The school proposed should be of the greatest value in furthering such investigations, and the possible economies resulting from them might far more than pay for the cost of the school.

As to the provision of the bill asking that certain duties, which are now in the hands of line officers, be transferred to the engineers, it can only be said that the demand is a reasonable one, and its granting will conduce to good discipline in the service. Under existing practice, for example, the operation of the electric plant of a battleship is in the charge of the line officers, so far as its ordinary service is concerned. But the engineers are charged with the responsibility of installing this machinery in the first place and of repairing it whenever it is out of order. As the engineers have this much responsibility, it would seem that they should be made responsible for its operation as well.

Again, it is an anomaly to entrust to line officers the inspection of material which is destined for use by the engineering department, and for which the engineers are responsible while in service.

The several demands made in the bill are in themselves sufficient evidence that reform is urgently needed, and these demands seem so reasonable and so much in accordance with the best interests of the naval service that any opposition thereto is a puzzle to landsmen. The popular estimate of the naval officer makes him a brave, generous and self-sacrificing man; and in the United States Navy, both line and staff, we know that this description applies to the large majority of the officers. But there are some jealous and narrow-minded men who still live in the traditions of the past, and who would sacrifice the welfare of the service for their own advancement and to maintain a very false and foolish idea of social caste. It is men of this class who block the way to these proposed reforms, now as in the past. But this opposition is so opposed to the sound development of our navy and to the national interests, that it ought in this case to prove futile.

LETTERS TO THE EDITOR.

Positions Open for Engineers.

Sir: I desire to inform you that examinations will shortly be held for the following positions: Computers, salary $900 to $1,500 per annum; transitmen, salary $1,200 per annum, and topographical draftsmen, salary $1,200 per annum.

The examinations for computers and topographical draftsmen will take place on the following days: Feb. 25, for computers, at 10 a. m.; Feb. 28, for topographical draftsmen, at same hour. No date has yet been set for examination of transitmen.

Yours respectfully, S. William Briscoe,
Secy. N. Y. City Civil Service Boards.
New Criminal Court Bldg., New York city, Feb. 15, 1896.

Simpler Formulas for the Flow of Water in Pipes.

Sir: Mr. Gould's formula under the above caption (Engineering News, Jan. 30), being derived from the well-known Chezy formula, with a coefficient of 80.6 for velocity, any other coefficient may be used by introducing it into the formula after dividing it by 80.6, or more simply by 80. Thus for C=100 in the Chezy form, the Gould formula for quality will read,

$$Q = 1.25 \sqrt{D^5 \times H}.$$

H.
New York, Feb. 16, 1896.

The Proper Length For Sewer Pipe—2 or 3 Ft.

Sir: The above question of long or short sewer pipe is one I do not remember of ever having heard discussed. There are, perhaps, others besides myself, who would be greatly interested in and benefited by a discussion of this subject.

A change from 2 to 3-ft. lengths of pipe is just now being considered in this city. It is alleged that the longer pipe are more difficult to manufacture—that is, they are much more liable to be crooked; while, on the other hand, the lesser number of joints in a sewer is certainly in favor of long pipe. Yours very truly,

Ben E. Briggs, Deputy City Engineer.
Erie, Pa., Feb. 13, 1896.

(Pipe of 3-ft. lengths were recommended by Mr. Freeman C. Coffin, M. Am. Soc. C. E., in a paper on tests of cement joints in sewer pipe, abstracted in Engineering News for Jan. 3, 1895.—Ed.)

Proper Consistency of Concrete After Mixing.

Sir: With all that has already been said in reference to "The Proper Consistency of Concrete after Mixing," I would beg to add a word in reference to a practical consideration which has not been fully brought out, and that is in reference to "placing." With all of our laboratory tests and "nice" theories, when it comes to the average workman you will find him disposed to treat concrete as so much "mud." With careless placing you will undoubtedly get the best results from "wet" concrete. But even with care in placing "dry" concrete it will "arch," as Mr. Ransom has said. In attempting to break it down and bring the "flim" to the surface you will have to do an excessive amount of heavy ramming. With a quick-setting cement this may not be accomplished before the concrete has begun to set. The greatest danger, however, lies in the possibility, or rather probability, of breaking the bond of the concrete below. By the use of a 30 to 35 lb. rammer (as specified in Prof. J. B. Johnson's "Engineering Contracts and Specifications"), on an imperfect cushion of "dry" concrete, you are almost certain to accomplish the destruction of the bond in the course beneath. By the use of the "quaking liver" concrete it can be placed, compacted, and smoothed off at once with a shovel. Or if a rammer is used, it should be broad and very light.

Another objection to the dry concrete is the "ragged edge" of dry stone where the concrete is mixed and placed in batches. It is impossible to get a bond with the edge of the preceding batch, without ramming, thereby disturbing that which has taken a partial set.

Yours respectfully, C. K. Mohler.
Cleveland, Ohio, Feb. 13, 1896.

Hydraulic Dredging for the Mississippi River Improvement.

Sir: In connection with the interesting letter of Prof. J. B. Johnson, C. E., in your issue of Feb. 6, pp. 94 and 95, on the Mississippi River navigation improvement and the prospects of dredging, and Colonel Flad's advocacy of that system, it may be of interest to quote from my reports, while in charge of a portion of the upper

Mississippi River, concerning the use of dredging. The Report of the Chief of Engineers, for 1887, contains on p. 1611 my expression: "Having become convinced by experience that effective dredging was a necessary part of the improvement of this portion of the river, . . . I recommended, last year, that a part of the appropriation be used for constructing a hydraulic dredge." An account then follows of the steps taken by me to build an experimental suction dredge, without great expense. The next year's report, p. 1463, gives an account of the performances of that dredge, on trial, for circumstances did not permit of an actual experience; but the report shows why I thought such a machine necessary.

The next report, 1889, p. 1720, gives an account of the successful use of that dredge in releasing a large steamer, the "War Eagle," from a sand bar, where she had been grounded on a falling river, in August, 1888. This is an actual exhibit of the possibilities of the use of an hydraulic dredge in releasing vessels from a sandy grounding. It is certain that to apply the means to the case of the "St. Paul" is only a question of a good machine, and common sense in application of the method, as noted in our issue of Feb. 6.

The report for 1890, p. 2007, gives an account of the use of the hydraulic dredge during the season of 1889, and it is especially noteworthy that on one occasion the channel of the river was moved, and practically controlled on a stretch not less than half a mile long and 500 ft. wide; and that the channel secured by three week's work maintained itself during the rest of the year.

That dredge secured good results at four places that season, and I have no doubt that the system, properly applied, is the true one for securing navigable channels through the shifting sand and mud bars of the Mississippi River. Very truly, etc.,

E. H. Ruffner,
Major of Engineers, U. S. A.

Room 20, P. O. Building, Baltimore, Md., Feb. 14, 1896.

Notes and Queries.

A. F., Cincinnati, asks: Can you refer me to any sources of information in regard to variable speed and reversing gears suitable for gas engines? Do any of your advertisers make a specialty of making friction gears?

T. O. H., Lancaster, Pa., writes:

The water that we use here is heavily impregnated with lime and very hard, and boilers last but a short time for that reason. Can you favor me, through your paper, with a remedy for this condition of the water so as to prevent scaling or deposits?

The best remedy for the formation of scale in boilers depends upon the chemical nature and the amount of the various substances held in solution in the feed water. The treatment for lime will vary according to whether it is present as carbonate, as sulphate, or as both together, and whether or not magnesia, clay, and organic matter are also present. The various remedies for different forms of impurity are: filtration of feed water, heating of feed in a live-steam feed water heater, and subsequent settling or filtering of the substances precipitated by the heating; frequent blowing off from the mud-drum and from the surface blow of the impurities which are separated from the water in the boiler; chemical treatment of the water in tanks outside of the boiler and subsequent settling or filtration, the chemicals used, caustic lime or soda, carbonate of soda, barium chloride, alum, etc., depending on the chemical analysis of the water; chemical treatment of the water inside of the boiler, with caustic soda, tannate of soda, kerosene, or with some substance known as a "boiler compound," the composition of which is kept secret by the seller, and which may or may not be suitable for the particular kind of water for which it is tried. Undoubtedly the best plan to pursue with a bad feed water is to have it analyzed by a chemist who makes a specialty of water analysis, and take his advice as to the best method of treatment.

A ROENTGEN RAY PHOTOGRAPH.

The recent discovery of Prof. Roentgen with respect to what in the newspaper vernacular is currently called "Photography by X Rays" has aroused a surprising amount of popular interest. We do not recall for a long time a scientific discovery which appears to have taken such a hold on the popular mind, if the space given to it in the newspapers be taken as a criterion. From a strictly scientific point of view, Roentgen's discoveries, interesting and important though they certainly are, do not appear after all to be any more important or deserving of fame than many of which the average newspaper reader never hears. The fact that heat, light and electricity are all wave motions of the ether is now elementary science, and that many solids opaque to light are transparent to electric radiation, has also been abundantly shown. The essence of Prof. Roentgen's discovery is that certain of these waves which are set up by electric vibrations and are capable of penetrating various solids as light passes through glass, can produce chemical action. Hence the possibility of photographing through opaque substances. The examples of this new photography which we have seen published in this country thus far have been of varying degrees of crudeness. Most of them

Photograph Made by One Hour's Exposure of a Hand to Roentgen Rays.

have been well calculated to raise doubts as to whether the claims put forth as to the wondrous applications of the process to modern surgery were not likely to prove ungrounded.

In looking over our German exchanges this week, however, we came across by all odds the finest specimen of photography on this new system that we have anywhere seen. It will readily be understood that if the new process can produce such clear and distinct photographs as that which we reproduce, it may prove of great value to the surgeons in the case of bone diseases or the lodgment of foreign substances in the body.

The negative from which the cut which we show was made was taken by Messrs. Eder and Valenta of the staff of the Austrian Government's laboratory for the testing of photographic and reproductive processes at Vienna. Placcker's glass bulbs were used for developing the electrical rays and were brightly fluorescent. The negative shown in our cut was made from the hand of a student, which was exposed for an hour, the sensitive plate being inside a closed wooden plate holder.

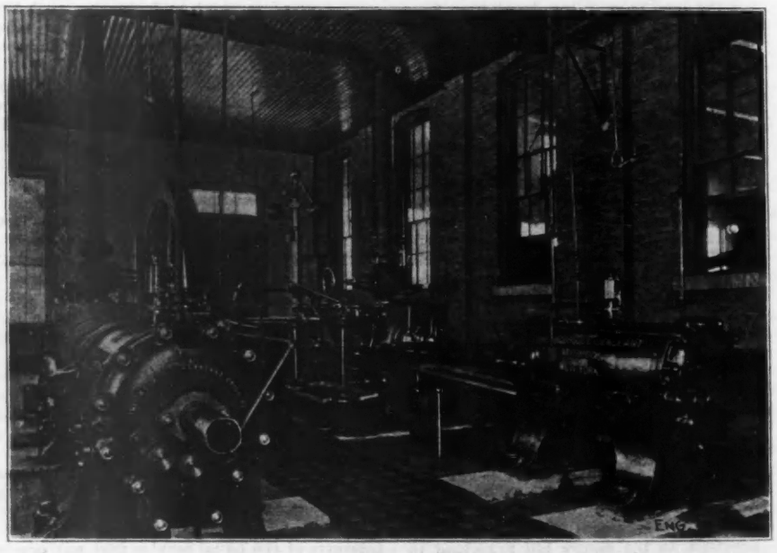
It will be noticed in the cut that the bones appear to be very loosely articulated. This is due, of course, to the fact that the connecting tendons, like the flesh, were transparent to the photographing rays and so do not appear.

POHLE AIR LIFT PUMPING PLANT, BLOOMINGTON, ILL.

We present herewith a view of a Pohle air lift pumping plant recently put in operation at Bloomington, Ill., under the direction of the Ingersall-Sergeant Drill Co., of New York city. The water is taken from four tubular wells 145 ft. deep, and it was estimated from the rough test made that at 50 revolutions about 4,500,000 gallons would be pumped every 24 hours. The compressor used is an Ingersoll-Sergeant duplex Corliss compressor of the piston-inlet type, with 16x36-in. steam and 16½x36-in. air cylinders. No special feature distinguishes the piping of the wells from ordinary well-known practice. The cost of the pumping plant was about $6,000.

The establishment of a free port at Fort Pond Bay, or elsewhere in the waters of Long Island Sound, is the subject of a bill presented to Congress by Mr. McCormick, of New York. This is the scheme advocated by Mr. Austin Corbin. The provisions of the bill propose the treatment of this whole port as a part of the bonded warehouse system. In this port foreign merchandise could be transferred from one vessel to another and loaded upon the piers without being entered or specially bonded; or it could be entered for immediate admission into the country, or warehoused and bonded and exported or entered for consumption. Factories could also be maintained within the limits of the port and materials might be used and the products exported under regulations prescribed by the Secretary of the Treasury. All vessels entering and leaving this port would be free from tonnage dues, entrance and clearing fees, and from local harbor-masters' fees under state laws. All dockage charges and fees for use of piers would be regulated by the Secretary of the Treasury. The proprietors of the port would bear all expenses of opening and maintaining it, including the building of breakwaters, lights, dredging, etc. This port would be practically modeled after those at Copenhagen, Hamburg and Bremen.

The Aransas Pass breakwater, in Texas, was completed on Jan. 22 last. The contract was let on July 3, 1895 to Messrs. Charles Clark & Co., for building 1,250 ft. of finished breakwater, extending 3 ft. above mean low tide, and 2,500 ft. of apron extension. The breakwater was founded on mattresses, 100x50 ft., loaded down with rip-rap, and faced and capped by large stone of 2 to 10 tons in weight. The consulting engineers were Messrs. Haupt, Ripley and Wisner, and Mr. Wm. Dunbar Jenkins, M. Am. Soc. C. E., was the engineer in charge.



VIEW OF POHLE'S AIR LIFT PUMPING PLANT; BLOOMINGTON, ILL.
Ingersoll-Sergeant Drill Co., New York, Builders.

REPORT ON THE YIELD OF THE PEQUANNOCK WATERSHED, NEW JERSEY.

A report has just been made to the Street and Water Commissioners of Jersey City by Mr. C. C. Vermuele on the ability of the East Jersey Water Co. to furnish Jersey City a temporary water supply from the surplus capacity of the works which were built by the company some years ago for the supply of Newark. Under its contract with Newark, the East Jersey Water Co. agreed to build works with a daily capacity of 50,000,000 gallons, but reserved the right until 1900 to sell all water not needed by Newark, that city to be entitled to use a maximum of 27,500,000 gallons a day. The works were put in operation in 1892, but the water sold by the company in 1895 averaged only about 1,000,000 gallons a day.

In the fall of 1895 the company secured a contract to furnish Jersey City a temporary supply. The understanding was that the company could supply 20,000,000 gallons and upwards per day, and that the contract would continue until Jersey City secured a permanent supply from the Rockaway River under a contract which was awarded to the Jersey City Water Co. on the same date that the contract with the East Jersey company was made. Some six weeks ago it was made known that the Pequannock pipe line, which supplies Newark, would not carry 50,000,000 gallons of water, and a few days later the award for a permanent supply above noted was set aside by the courts.

The East Jersey Water Co. was obliged to notify Jersey City that it could not at present supply the amount of water it had agreed to furnish, but it also stated that the pipe line deficiency would speedily be made good by the construction of a second conduit. Meanwhile it offered to furnish what water it could at $20 per 1,000,000 gallons, instead of $43, as provided by the contract.

The Street and Water Commissioners sought advice from Mr. Vermuele, especially as there were doubts regarding the yield of the drainage area, from which the East Jersey company draws its supply, with the storage capacity now provided. Mr. Vermuele's report was submitted on Feb. 10. He concludes that with the present conduit dependence can be had upon only 7,000,000 gallons a day as a minimum over the supply of Newark and other towns which have contracts with the East Jersey company. In times of light consumption in Newark the surplus available for Jersey City might reach double this amount. He thinks that before the spring of 1897 the conduit capacity might be so increased as to supply the whole consumption of Jersey City, but he declares that the present storage capacity of 6,000,000,000 gallons must be increased to 11,000,000,000 gallons if the drainage area is to yield 50,000,000 gallons a day. Additional reservoirs, he says, could not be constructed and made ready for use before 1898, which would leave only two years during which Jersey City could draw from the Pequannock, since Newark is to have the whole supply in 1900, and the Newark contract prohibits the sale of water by that city outside of Newark and two or three small townships after 1900. Hence Jersey City could not buy of Newark after the above date unless the provision cited should be declared void by the courts, as against public policy.

Mr. Vermuele says the carrying capacity of the present 48-in. steel pipe line has been determined to be a little less than 36,000,000 gallons a day. Newark sometimes draws her full 27,500,000 gallons and the other communities dependent on the pipe will require in 1896 about 1,500,000 gallons, leaving 7,000,000 gallons a day as a minimum supply for Jersey City. Mr. Vermuele's argument regarding the need for more storage capacity is as follows:

> The question next arises, whether the building of this main alone will put the company in a position of undoubted ability to perform its contract. In other words, supposing the mains to be sufficient, has it storage enough on its watershed to insure a delivery of 50,000,000 gallons daily at all times. The area of the Pequannock watershed is stated by Mr. Herschel to be 62.6 sq. miles, while my own measurements make it 63.7 sq. miles, which I believe to be more nearly correct. In my report on water supply, on page 129, I give a table of flow applicable to the Pequannock, which shows that during the driest year the average yield will be 801,000 gallons daily for each square mile. This is for a year which is extremely dry, and only one equally dry year has occurred since 1825. Since this would make the yield of the Pequannock watershed over 50,000,000 gallons daily, it is evident that there is water enough to be had there, provided there is sufficient storage to make up the shortage of the dry months when the river supplies very little water. The rainfall of such a dry year amounts to about 31.6 ins., while once in seven years we are likely to have a year with about 35 ins. rainfall, and the average rainfall is 44 ins.
>
> Since June, 1891, the East Jersey Co. has kept records of the yield of the Pequannock River at their intake. The rainfall during these years has been 42.8, 48.74, 46.78 and 44.37 ins., showing that none of them have been very much below the average; consequently, at no time has the river run as low as it may be expected to do. From June to November, 1891, the rainfall was 19.75 ins., the average for these months being 22.82 ins., and the driest 12.01. It will be seen that this was by no means an exceptionally dry period. Mr. Herschel has furnished the yield of the Pequannock River during these months, also an estimate of what would have been the condition of his reservoirs if 50,000,000 gallons daily had been drawn. Table I. is a copy of his record.

Table I.—Flow of the Pequannock River at Macopin Intake Dam and Volume in Reservoirs if 50,000,000 gallons per Day Had Been Drawn Through the Conduit June 1 to Nov. 1, 1891.

Week ending	Total natural flow of river at intake dam.	Taken from or added to storage.	Volume in reservoir.	Total unavoidable waste.
June 7.....	218	-132	5,965	0
June 14.....	174	-176	5,789	0
June 21.....	93	-257	5,532	0
June 28.....	104	-246	5,286	0
July 5.....	72	-278	5,008	0
July 12.....	59	-291	4,717	0
July 19.....	49	-301	4,416	0
July 26.....	73	-277	4,139	0
Aug. 2.....	91	-259	3,880	0
Aug. 9.....	76	-274	3,606	0
Aug. 16.....	71	-279	3,327	0
Aug. 23.....	162	-188	3,139	0
Aug. 30.....	1,145	664	3,803	0
Sept. 6	403	53	3,856	131
Sept. 13.....	322	-28	3,828	0
Sept. 20.....	145	-205	3,623	0
Sept. 27.....	114	-236	3,387	0
Oct. 4.....	99	-251	3,136	0
Oct. 11.....	103	-247	2,889	0
Oct. 18.....	73	-277	2,612	0
Oct. 25.....	94	-256	2,356	0
Nov. 1.....	66	-284	2,072	0
Nov. 8.....	73	-277	1,795	0
Nov. 15.....	171	-179	1,616	0

All quantities in million gallons.

The capacity of Oak Ridge reservoir is 2,558,000,000 gallons, and it receives the drainage of 27.3 sq. miles. Clinton reservoir has a capacity of 3,539,000,000 gallons, and receives the drainage from 9.5 sq. miles. The intake reservoir at Macopin is only large enough to equalize the flow of the pipe, and affords no storage whatever. Below Oak Ridge and Clinton reservoirs, 24.4 sq. miles of watershed has no storage whatever, and at any time when the flow from this part of the watershed exceeds the amount of water taken into the pipe there is water wasted over Macopin dam, often in large amounts.

In the table Mr. Herschel has assumed that during any week, when the average flow of this lower part of the watershed is 50,000,000 gallons daily, he will catch it all. This is a dangerous assumption from the fact that because of heavy showers during a dry time, a sudden rush of water might come amounting to five times the capacity of the pipe, although the total flow-off for the same week might not be over 350,000,000 gallons, or an average of 50,000,000 gallons daily; but on this assumption, starting with June 1, with his reservoirs full, on November 15 he has 1,616,000,000 gallons left in storage.

It must be remembered that this is an estimate based on the assumption that the reservoirs would have been full June 1. The reservoirs were not then full and were not in use, but were under construction, and there are several errors in the assumption: First, the reservoirs would not have been full on June 1, because gagings made by me during May, of that year, which are given on p. 176 of my report on water supply, show that the yield of the stream at Macopin intake was only 674,000,000 gallons for the month, while at 50,000,000 gallons a day the draft would have been 1,500,000,000 gallons; consequently we should have had to draw from the reservoir 876,000,000 gallons that month.

Next, no account is taken of evaporation from the reservoirs, because they were not then in use. The two reservoirs have 800 acres of surface, and the evaporation from this, during the period from May 1 to Nov. 15, would have been 662,000,000 gallons. Adding this evaporation to the amount which we would have had to draw for May, we find that 1,538,000,000 of the 1,616,000,000 gallons balance reported by Mr. Herschel would have disappeared, so that on Nov. 15 he would have actually had only 78,000,000 gallons in his reservoir or about 1½ days' supply, and as relief did not come until about that length of time after the 15th, his reservoirs would really have been empty. This is what actually happened, according to Mr. Herschel's own measurements, during a year, which was not, by any means, a dry one, accepting his assumption that there would be no waste at Macopin.

Any one acquainted with the flow of the Pequannock knows, however, that no period of 168 days such as covered by the above table, could have passed without a very considerable amount of water wasting over Macopin dam. The storage reservoirs are situated about from 8 to 9 miles above the intake, measuring along the stream. In order to keep the pipe full, the gates at the reservoirs above must be adjusted so as to keep the flow of the river up to 50,000,000 gallons daily, and in the event of a sudden shower during the summer it would be impossible to close these gates just at the right time to avoid waste. Then, again, at times, even if these gates were shut, the rate of discharge from the lower part of the watershead not furnished with storage would for a day or more be greater than the capacity of the conduit, and it is impossible to deny that in actual operation there would have been a deficiency at the close of the period above shown which would have cut off the supply both of Newark and Jersey City for a considerable period. You will appreciate that the effect of such a deficiency might be not merely the cutting off of your own supply, but that of Newark, for in approaching such a danger point the tendency is always to hope for a breaking up of the drought and to continue drawing until the reservoirs are empty. We must expect, however, that in such an emergency Newark would be on her guard, and when the reservoirs were drawn down to an extent which threatened failure she would enjoin the furnishing of any water from that source to Jersey City, and unpleasant complications would be the result.

Following this period of failure in 1891, there were three years of abundant rainfall, and the lowest point reached during this time by Mr. Herschel's estimates would have been Nov. 13, 1892, when the balance in the reservoirs would have been 1,442,000,000 gallons, or about 28 days' supply. The year 1895 just past, is looked upon as a dry one, but it has not really been as dry as was supposed. The summer rainfall during the past year amounted to 11.21 ins. in the highland district, while for the autumn months it was 8.22 ins., giving a total for six months from June to November of 19.43 ins., whereas the average of these months is 22.8 ins., and the least to be expected 12.01 ins.; therefore that for 1895 was not as low as the rainfall of an ordinary dry year.

The East Jersey Water Co. has reported to us the flow of the Pequannock River, and its estimate of what the condition of the reservoirs would have been if it had furnished 50,000,000 gallons daily. This report is continuous up to Jan. 26, 1896. According to the report the reservoirs would have been full June 2 for the last time. Table II. is a copy of the record since.

This table is made up on the same assumption as the previous one, namely, that during any week in which the total flow at Macopin dam does not exceed 350,000,000 gallons, the whole flow can be taken into the conduit with a draft of 50,000,000 gallons daily. We must again point out the error of this assumption, and enforce it by a single illustration. During the week ending Dec. 29 last the total flow is reported at 362,-

Table II.—Flow of the Pequannock River at Macopin Intake Dam and Volume in Reservoirs, if 50,000,000 Gallons per Day Had Been Drawn Through the Conduit May 27, 1895, to Jan. 26, 1896.

Week ending	Total natural flow of river at intake dam.	Taken from or added to storage.	Volume in reservoirs	Total unavoidable waste.
June 2.....	446	174	6,073	22
June 9.....	182	-168	5,905	0
June 16.....	117	-233	5,672	0
June 23.....	76	-274	5,398	0
June 30.....	201	-149	5,249	0
July 7.....	411	61	5,310	0
July 14.....	129	-221	5,089	0
July 21.....	110	-240	4,849	0
July 28.....	90	-260	4,589	0
Aug. 4	95	-255	4,334	0
Aug. 11.....	176	-174	4,160	0
Aug. 18.....	94	-256	3,904	0
Aug. 25.....	10	-340	3,564	0
Sept. 1.....	47	-303	3,261	0
Sept. 8.....	25	-325	2,936	0
Sept. 15.....	3	-347	2,589	0
Sept. 22.....	43	-307	2,282	0
Sept. 29.....	30	-320	1,962	0
Oct. 6.....	28	-322	1,640	0
Oct. 13.....	97	-253	1,387	0
Oct. 20.....	131	-219	1,168	0
Oct. 27.....	48	-302	866	0
Nov. 3.....	166	-184	682	0
Nov. 10.....	185	-165	517	0
Nov. 17.....	166	-154	363	0
Nov. 24.....	108	-242	121	0
Dec. 1.....	440	190	311	0
Dec. 8.....	525	-25	186	0
Dec. 15.....	125	-225	-39	0
Dec. 22.....	217	-133	-172	0
Dec. 9.....	362	112	-160	0
Jan. 5, 1896...	798	448	288	0
Jan. 12.....	269	-81	207	0
Jan. 19.....	189	-161	46	0
Jan. 26.....	487	137	183	0

All quantities in million gallons. Reservoirs are empty during last three weeks in December.

000,000 gallons, and t table assumes that all this would be collected, but as a matter of fact, according to Mr. Sherrerd's record, 94,000,000 gallons of this flowed off in a single day, and even if we assume that the gates in the reservoirs had been closed just at the right moment, which we have stated to be impossible, the waste during the week would have been 44,000,000 gallons. It may be asserted with perfect confidence, therefore, that on the showing made by this table there would have been empty reservoirs early in November. Even as it is here figured out there were empty reservoirs during the last three weeks in December.

After referring to records of actual storage reservoir levels and waste over Macopin dam, kept by Mr. Morris R. Sherrerd, Assoc. M. Am. Soc. C. E., Engineer of the Newark Water Department, Mr. Vermuele continues as follows:

As to the waste over the dam at Macopin we find not only evidence from Mr. Sherrerd's record that it cannot all be collected, as is assumed in the East Jersey tables, but also evidence that the waste during the winter months may often be rated too high. This waste is ascertained by a gage which shows how high the water in the intake reservoir stands above the overflow of the dam. This overflow during the winter is frequently checked by ice, and, in consequence, the records show a waste which does not actually exist. This fact was known to Mr. Sherrerd, but he had not yet been able to remedy it. On the day of my visit, the records show a waste of over 52,000,000 gallons, but ice was then on the crest of the overflow, as is shown by a photograph which accompanies this report (not reproduced.—Ed.), and I can confidently assert that only a very small percentage of this amount was actually wasted.

Now the East Jersey reservoirs have been drawn down continuously from June 3 to Jan. 22, 1896, so that it is perfectly fair to assume that during these prolonged and threatening dry periods, when it was to the interest of the East Jersey Co. to make the best possible showing of the capacity of their plant, there was actually no important amount of waste over Macopin dam which could have been prevented with a draft into the conduit such as is shown by their records. Therefore, the only water which they did not collect and deliver was the additional amount which could have been saved from the waste at Macopin by virtue of a draft increased to 50,000,000 gallons daily. We find that on this assumption only 33,000,000 gallons additional could have been saved during the entire period covered by Table II. The total available supply from June 3 to Dec. 1, therefore, is made up as follows:

	Gallons.
Quantity actually in reservoirs Dec. 1	3,300,000,000
Waste which could have been collected if 50,000,000 gallons daily had been drawn	33,000,000
Total draft of conduit from June 3 to Dec. 1	4,266,000,000
Total available supply	7,599,000,000

To have drawn 50,000,000 gallons daily, during this period of 181 days, would have required 9,050,000,000 gallons. The deficiency on Dec. 1, therefore, would have been 1,451,000,000 gallons, or about 29 days' supply. But the dry period has continued up to the present date, and we find that on Jan. 22 there was actually in storage 3,690,000,000 gallons, against 3,300,000,000 on Dec. 1, showing a net gain in the reservoirs, during the period, of 390,000,000 gallons. The total draft of the conduit, during this period, was 1,448,000,000 gallons, while we estimate that there might have been collected from the waste over Macopin dam, if the draft had been increased to 50,000,000 gallons daily, an additional 427,000,000 gallons. Adding these amounts, we find the total available supply, from Dec. 2 to Jan. 22, to be 2,265,000,000 gallons. To have supplied 50,000,000 gallons daily, during this period of 52 days, we should have needed 2,600,000,000 gallons, so that the deficiency during this period would have amounted to 335,000,000 gallons. As the deficiency on Dec. 1 was 1,451,000,000 gallons this would make a total deficiency, up to Jan. 22, 1,786,000,000 gallons of storage.

Had the water been turned on, therefore, last June, and an attempt made to supply Jersey City with the amount of water called for by the contract, it can readily be seen that Newark's supply would have been so seriously imperilled by the first of November that she would have taken all legal means to prevent the delivery of any further supply to Jersey City, and from that date up to Jan. 22, the yield of the river would have, at no time, warranted a resumption of the supply to Jersey City. It will be seen, therefore, that if we take Mr. Herschel's own method of computation, involving the impossible collection of waste, there would still be a shortage; but if we follow the more rational course, and assume that as a matter of fact it is highly improbable that the East Jersey Co. have allowed, during this extreme dry period, any considerable waste which they could actually prevent, the shortage would be very serious. We find, therefore, that during the period covered by the East Jersey report, from June 1, 1891, to the present date, a period of 4½ years, there would have been two failures to supply 50,000,000 gallons daily, and that, too, in the face of the fact that we have, at no time, had droughts as severe as may be expected. It is true that some waste may have been allowed to go to certain mills at Butler, of which the water rights have not been acquired. We have no assurance that this waste will not have to be continued; but, in any case, we cannot consider it would greatly alter our conclusions. In order to make this point more clear, and to show certain defects in plan in the present works of the East Jersey Co., which are worthy of your consideration, I shall submit some further tables.

Mr. Vermuele next considers the condition of storage during excessively dry periods. Space prevents giving this discussion in detail.*

The figures show that for the driest periods on record the Oak Ridge reservoir would be empty 7, and the Clinton 4, out of 20 months, both reservoirs being empty at the same time for three months, while for four months the works would yield successively 37, 10, 7 and 11 million gallons a day. Such a period would not only leave Jersey City without any water, but would fall far short of giving Newark the 27,500,000 gallons to which it is now entitled, to say nothing of the 50,000,000 called for by the contract. Including evaporataion the results of the detailed figures given in this study show a need for 5,219,000,000 gallons of additional storage, making no allowance for the small storage at the intake dam. The figures also show that the Oak Ridge reservoir is too small and the Clinton too large for their respective drainage areas. The Clinton reservoir, according to the figures given, after having been empty four months would have filled only three-quarters full in the next eleven months, with the gates shut during the whole period.

In conclusion Mr. Vermuele says:

The full supply which you need for temporary purposes can only be obtained, therefore, by the construction of a new conduit 21 miles long, and storage reservoirs of 5,000,000,000 gallons capacity, in addition to those now in use. While the company expresses a willingness to increase the capacity of the plant, you cannot look for the accomplishment of all this work before the spring of 1898, while their right to the water expires in September, 1900; therefore, in order to secure a limited supply which you will be in the full enjoyment of a little over two years, you must see that works are built, which, if built under a permanent contract, will afford you the beginning of a permanent and reliable supply from some independent source. It is, perhaps, needless to remind you that no such step was contemplated when you decided to procure a temporary supply of water. Your decision was reached on the assurance that the works which would deliver such a supply were already in existence.

As to the value of such a supply as can be procured pending the construction of these additional works, we have, for the first year, a quantity ranging irregularly from 7,000,000 to 14,000,000 gallons daily, which, at $20 per 1,000,000 gallons, will cost probably $73,000. For the second year, beginning with the completion of the new conduit, the price will probably increase to $43 per 1,000,000 gallons, while the amount which you can obtain throughout the year is entirely problematical, but perhaps $200,000 may be taken as the probable least cost during that year. But little saving can be effected at your Belleville pumping station to offset this expense. It will be practically an additional charge. If it is to be assessed upon the whole city, the water must not be delivered to a certain district, but must be mingled with the Passaic supply. The proportions will vary from ¾ to ½ pure Pequannock water to from ¼ to ½ polluted Passaic water. The result would be that the whole supply would be probably more tolerable, but still polluted and unsafe. The Pequannock supply will be least reliable when the Passaic is in its worst condition, and when a return to the use of that source alone will be most objectionable. It would seem that the very slight relief which may be obtained from the Pequannock during the next two years will be at too great cost and too much risk of legal complications with Newark, or disputes with the company.

Since Mr. Vermuele's report was written, an agreement has been made between the Newark city officials and representatives of the East Jersey Water Co., subect to ratification by the directors of the company, in accordance with which the company will parallel the present Newark pipe line from the Macopin intake to the Belleville reservoir, laying five miles of 48-in. steel pipe to Pompton Notch and 16 miles of 42-in. the balance of the distance. Since this agreement was made Mr. W. H. Corbin, "of counsel for the company," has made the following statements regarding what his company "expects to do" for Jersey City if it receives the contract for a temporary supply:

(1) From now till June 15 to supply from 12,000,000 to 15,000,000 gallons per day of Pequannock water.
(2) From June 15 to Nov. 1 to supply from 18,000,000 to 21,000,000 gallons per day.
(3) After Nov. 1 to supply all that Jersey City may desire.

As indicating what the company can do at present Mr. Corbin gives the daily record of water furnished Newark from Jan. 10 until Feb. 11, inclusive, the average for January being 9,200,000 gallons, with a minimum of 4,300,000 and a maximum of 12,800,000 gallons, and the average for February being 12,200,000, with a minimum and a maximum of 9,100,000 and 13,700,000 gallons, respectively. The increased supply on June 15, assumed by Mr. Corbin, is on the supposition that the five miles of 48-in. duplicate conduit will be in operation by that time, while he also supposes that the whole of the new line will be finished by Nov. 1. Mr. Corbin states that work is already under way and that the contractors are under heavy penalties to complete it by Nov. 1.

We assume that the above statements are correct, as they were sent to us by Mr. Clemens Herschel, M. Am. Soc. C. E., Chief Engineer of the East Jersey Water Co., in the form of a newspaper interview. At the same time Mr. Herschel sent a reply to Mr. Vermuele's report, made in the same way. This reply is as follows:

As to invoking the experience of a century to settle the conditions of supply of water under a contract for a temporary supply, I have nothing to say, except that it seems to me to be a most ponderous way of handling the subject.

But, in attacking the reports that have been made from month to month of the yield of the Pequannock watershed, supposing a draft of 50,000,000 gallons each day, he is wrong because his premises are wrong. It is not necessary to go into details. One illustration will suffice.

The report states that it is fair to assume that the East Jersey Water Co. has been saving all the water possible at the intake on account of the drought during the last six months of 1895. The contrary is the truth. The gate-keeper has been specially instructed never to let the dam go dry.

The company in the operation of its works has always carefully distinguished between measuring the yield of the whole drainage area, on the one hand, and the necessities of the present supply for Newark, which is less than one-half of the ultimate capacity of the works on the other.

The truth is that, instead of wasting no water, as was assumed in the report, the company has actually and purposely wasted during the six months mentioned about 2,200,000,000 gallons, thus making completely void the computation which, in the report, resulted in showing a deficiency of over 29 days' supply.

Water was wasted in pursuance of an old injunction to pass enough water to make power by steam at Butler, but which had long ago been revoked by awards made in those cases. However, there being no particular embarrassment to the company in wasting this water, so long as there was demand for less than one-half of the ultimate capacity of the works, the old method of operating the works, under the injunction before referred to, had ben allowed to continue. It was only within a few weeks, in speaking of the matter incidentally to counsel, he advised the company that the injunction was no longer in force.

Undoubtedly some more storage capacity will be needed, but up to the present time this deficiency has been shown to be less than 200,000,000 gallons, or three or four days' supply. The exact amount will be determined in due time. To make this matter clearer, I will put it this way: The works have been shown to yield 49,000,000 gallons daily in 1895, and considerably over 50,000,000 gallons per day throughout each of the preceding four years.

So much is certain: All experience up to the present time has shown that the results found in the Croton watershed and the drainage area from which Boston's supply is drawn are not applicable to the Pequannock watershed. This the records of the past four years have demonstrated beyond recall. Year after year there is lost in the Pequannock watershed by evaporation and other causes about 16 ins. of the annual rainfall, while in both the Croton and Boston drainage areas the loss is from 21 to 24 ins. Mr. Vermeule has noticed the same difference in the yield of certain streams in New Jersey, and accounts for it solely by differences in the temperature.

Whatever need for a supplementary reservoir may be decided upon, it will have been constructed before September, 1900. It is evident that Newark has no need for a supplementary reservoir before 1900, as the exist-

*The report was published in the Jersey City "Journal" and "News" of Feb. 11, but the latter paper omitted the tables.

ing development of the drainage area is ample not only to supply the 27,500,000 gallons, to which Newark is entitled, but very much more.

The contract to supply Jersey City only contemplated a delivery through the conduit to the two cities and the other small towns of 44,000,000 gallons per day, and the supply of so much at the intake is already assured. It is to the interest of the East Jersey Water Co. to increase this supply at once so as to have more water to sell.

SUSPENDED FIRE PROTECTION SHIELD FOR PABST BUILDING; MILWAUKEE, WIS.

We illustrate in the accompanying cuts a suspended fireproof shield designed for the purpose of protecting the rear or elevator shaft wall of the Pabst Building in Milwaukee, Wis., against fire So far as we know this is the first time that a suspended shield or armor has been used for protecting the exterior wall of a building from fire, and we illustrate it in some detail.

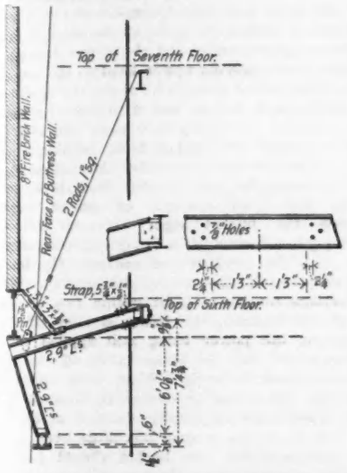


Fig. 1.—Sketch Showing Construction of Fire Protection Shield for Pabst Building, Milwaukee, Wis.

A five-story building adjoins the Pabst Building. As this building is used as a furniture factory and filled with oils, varnishes and other inflammable material, it will be seen that in case of a fire the elevator shaft of the Pabst Building would be seriously jeopardized, especially as the three columns in this elevator shaft wall have only 4 ins. of brick-

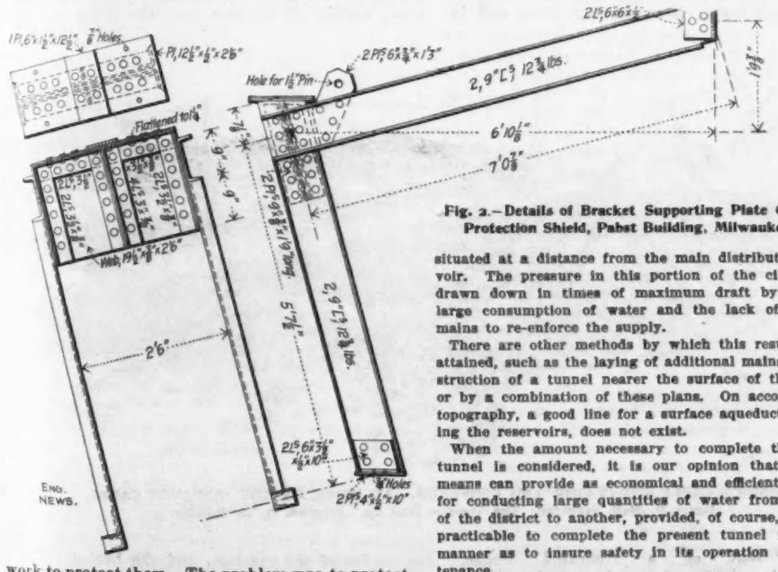

1 Pl. 6"x 1/2" x 12 1/2" 7/8" Holes
Pl. 12 1/2" x 1/2" x 2'6"
Hole for 1 1/2" Pin
2 Pl. 6" x 3/4" x 13"
2'9" L's 12 3/4 lbs.
Flattened to 1/4"
6'10 1/8"
7'0 3/8"
Web Pl. 9 1/2" x 3/8" x 2'6"
2'6"
2 L's 6" x 6" x 1/2"
2 Pl's 6" x 1/2" x 10"
7/8" Holes
2 Pl's 6" x 1/2" x 10"
ENG. NEWS.

Fig. 2.—Details of Bracket Supporting Plate Girder for Protection Shield, Pabst Building, Milwaukee, Wis.

work to protect them. The problem was to protect these columns so that in the event of a fire occurring in the furniture factory they would not be warped out of plumb and thus prevent the running of the elevators.

As shown by Fig. 1, the fire shield begins at the top of the sixth floor, where it is supported by a heavy plate girder, and it extends up to the eleventh floor, being firmly anchored to the building wall at intervals. It is 8 ins. thick, constructed of No. 1 fire brick laid in Portland cement mortar with 1/8-in. joints.

The plate girder on which the wall rests is 38 ft. 3 ins. long and 30 ins. deep. At one end it rests on a brick chimney and at the other on a bracket, as shown in Fig. 1, and also in more detail in Fig. 2. This bracket straddles the buttress wall on which it rests and is hung to the beams of the sixth and seventh floors. Fig. 2 shows the construction of the bracket in detail. The plate girder is made up of 29 3/4 x 3/8 ins. webs, 6x6x9-16 ins. angle chords, and 3 1/2 x 3 1/2 x 3/8 ins. angle stiffeners. Owing to the contracted space, it had to be erected in three parts, and the field connections were reinforced with heavy splice plates and angles. The girder was fireproofed by being covered with 2 ins. of pine plank sheeted with tin, and the remainder of the ironwork was fireproofed with hollow tile.

The fire shield was designed by Mr. Albert Wolf, Civil Engineer, Chicago, Ill., the engineer for the ironwork of the Pabst Building, and we are indebted to this gentleman for the matter from which our illustration and this description have been prepared.

REPORT ON THE ADVISABILITY OF COMPLETING THE ABANDONED AQUEDUCT TUNNEL, WASHINGTON, D. C.

The completion of the Washington aqueduct tunnel has been recommended in a report by W. L. Marshall, Major, and Jas. L. Lusk, Captain, Corps of Engineers, U. S. A; A. Fteley, M. Am. Soc. C. E., and Desmond Fitz Gerald, M. Am. Soc. C. E., Captain D. D. Gaillard, Corps of Engineers, signing the report as recorder.

The aqueduct is about four miles long, wholly in rock tunnel at a depth of about 150 ft. below the surface. It was abandoned in 1889, owing to most serious defects in construction, after the tunnel had been driven and all but about 6,000 ft. of it lined. The commission was instructed to report on the feasibility of completing the tunnel, or if not feasible upon a substitute for it. The most interesting portions of the report are given in the following condensation, which employs the language of the commission throughout, but omits some of the minor points discussed and also omits descriptions of some of the proposed accessories:

The principal object for the construction of the tunnel was to provide means for carrying a large amount of water, with but a small loss of head, from the terminus of the Washington aqueduct to the new reservoir, thus maintaining the pressure in a large part of the city situated at a distance from the main distributing reservoir. The pressure in this portion of the city is now drawn down in times of maximum draft by the very large consumption of water and the lack of sufficient mains to re-enforce the supply.

There are other methods by which this result can be attained, such as the laying of additional mains, the construction of a tunnel nearer the surface of the ground, or by a combination of these plans. On account of the topography, a good line for a surface aqueduct, connecting the reservoirs, does not exist.

When the amount necessary to complete the present tunnel is considered, it is our opinion that no other means can provide as economical and efficient a method for conducting large quantities of water from one part of the district to another, provided, of course, that it is practicable to complete the present tunnel in such a manner as to insure safety in its operation and maintenance.

With the slight differences of level existing between the distributing reservoir and the new reservoir, which is about 2 ft., the capacity of the tunnel, according to our computations, is equal to that of nine 48-in. pipes, or more than three 6-ft. pipes of the same length. Considering the requirements of the city in the near future, the addition to the distributing system of a structure of such large carrying capacity must prove of inestimable advantage.

Careful examination of the nature and condition of the rock through which the tunnel is built has convinced us that it can be relied upon to withstand safely the pressure to which it will be submitted when the tunnel is filled with water and subjected to the maximum hydrostatic pressure. We found the rock, with but few exceptions, to be sound, strong and hard. Although practically unsupported, the rock has only fallen in two or three places, and to an amount which we consider trivial.

One of the objections against the tunnel that has been urged with much force is the liability of leakage or percolation outward from the tunnel into the ground when it is subjected to the pressure of the water. It is evident that should the leakage be sufficiently great, the dangers to be apprehended from this source might be considerable. These possible dangers, however, are materially lessened by a consideration of the fact that from all the information we have been able to collect, it appears that for a considerable portion of the tunnel the natural level of the water in the ground is not far different from that of the hydraulic grade line of the water in the tunnel.

Since this tunnel was abandoned the new Croton aqueduct supplying the city of New York with water has been completed. A portion of this aqueduct, embracing a length of about seven miles, is subjected to internal pressure with a maximum pressure due to a head of about 130 ft. In this case no serious percolation has been observed, although the surface of the ground is at several points much below the hydraulic grade line. An experiment made for the purpose of determining the amount of this leakage outward from the aqueduct showed that the total loss in the whole seven miles from this cause did not exceed 225,000 gallons in 24 hours.

With this practical example before the commission, and guided by our judgment and experience, we believe that if the spaces now existing between the brickwork and the rock are thoroughly filled with rubble masonry and grouted, the tunnel can be made sufficiently water-tight, and that the leakage under a head of 150 ft. will not be large enough to prove an obstacle in the way of the successful completion and operation of the tunnel. In this connection we recommend that the interior surface of the whole tunnel should receive a double coating or wash of pure Portland cement. This treatment will aid materially in making the brickwork more impervious to the passage of water.

Our examination of those portions of the tunnel already lined, taken in connection with the published testimony and supplemented by the statements of others whom we have called before us, shows that there is a great diversity in the character of the lining. In some portions of the tunnel vertical rubble sidewalls have been built. Where these occur, we have been unable to find any void spaces of magnitude behind the walls. In other cases the sidewalls are built of brick, generally filled on the outside to the crown of the arch with loose packing. Some portions contain a brick invert. As a general rule, empty spaces exist over the crown of the arch. In the westerly part of the tunnel these spaces are comparatively small, but in the easterly portion they are much larger, in some cases extending to more than 10 ft. in height. These cavities must be filled with rubble masonry laid solidly in cement mortar. In some cases timbering exists in the spaces over the arch. The timbering should be taken out in sections and rubble masonry substituted. Where the spaces will not allow of laying rubble masonry, provision has been made for filling the spaces with stone packed by hand, and then grouting the whole mass with cement under pressure.

Where no invert now exists, we recommend a slight excavation of the rock and the building of an invert of Portland cement concrete smoothly finished.

As the Rock creek portion is the lowest level in the tunnel and there is here but a small amount of material over the arch, this point has been selected for the construction of a 40-in. blow-off with gates, to empty the tunnel of all the water which can be taken out, with the exception of that which must be pumped. The shaft is to be provided with a metal lining 6 ft. in diameter, backed with brick and concrete. To this lining will be attached a cover of sufficient strength to resist the internal pressure. The shaft will be protected by a brick house provided with hoisting apparatus. A short distance from the shaft an excavation will be made in the rock to receive a large pump pit, surrounded with a heavy wall and containing the pumping machinery, the whole covered by a substantial superstructure. A boiler house will contain the necessary boilers for supplying power to the pumps, which will be of sufficient capacity to raise 12,000,000 gallons in 24 hours from the level of the tunnel to Rock creek.

The estimated cost of the work is $897,837, of which $181,010 is for completing the lined portion and $278,012 for finishing the unlined portion; $138,000 for reinforcing the tunnel for about 1,000 ft. at Rock creek, to prevent weakness on account of its proximity to the surface; $220,315 for various appurtenances; and $80,500 for cleaning and coating the tunnel and pumping expenses during construction. The report of the board is approved by Gen. Craighill, Chief of Engineers.

PROGRESS OF WORK ON THE CHICAGO DRAINAGE CANAL.

The total amount of excavation on the Chicago Main Drainage Channel completed Dec. 31, 1895, was 31,145,090 cu. yds., or 77.22% of the whole excavation, according to the annual report of the Chief Engineer, Isham Randolph, which has just been issued. On the same date the total cost of the work completed amounted to $14,714,528, of which sum $6,277,268 was expended in 1895. The total amount involved in the existing contracts and in the work performed directly by the Sanitary District at the same date was $19,064,827, which makes the percentage of the work accomplished 77.18% on the basis of values. The accompanying diagram shows the percentage of excavation completed on each contract section and is self-explanatory.

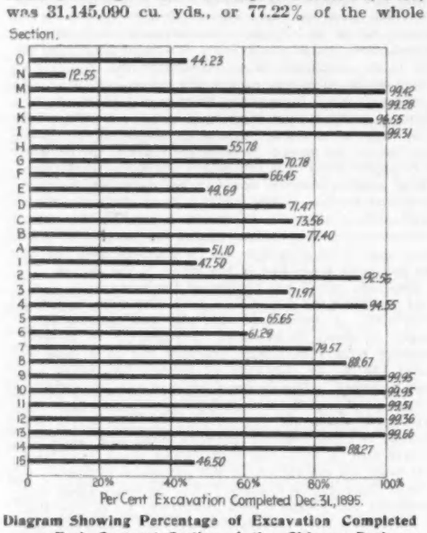


Diagram Showing Percentage of Excavation Completed on Each Contract Section of the Chicago Drainage Canal, Dec. 31, 1895.

A COMBINED CABLE EXCAVATOR AND CONVEYOR.

We illustrate herewith a very simple and effective cableway which combines the functions of an ordinary cableway transporting system, with self-filling buckets. It was recently employed in excavating the Suwanee Canal, in Georgia. This cableway was invented by Mr. James R. Hall, of Atlanta, Ga., and is manufactured by the Trenton Iron Co., Trenton, N. J., to whom we are indebted for the photographs. According to a letter in Engineering News of Oct. 17, 1895, the use of a self-filling bucket in connection with a cableway is not entirely new, a patent having been obtained in 1882 by Mr. Howard A. Carson, Am. Soc., C. E. for such a combination, but the apparatus of Mr. Hall, shown herewith, has many novel features, and is remarkable for the simplicity of the means by which its results are effected.

As shown in the illustration, a mast is mounted upon skids alongside one bank of the canal, and another mast is erected firmly in the ground on the opposite side about 200 ft. distant. If a tree is convenient it may take the place of the latter mast. These two masts constitute the supports for the stationary carrying cable, serving as a track for the hoist carriage, through which the operating ropes are rove, and below which the bucket hangs. They are secured by guy ropes to stumps of trees or buried logs, commonly known as "dead men." For convenience of description we will call the mast on the skids, the power-station mast, and the opposite one the spoil-bank mast. The skids upon which the power-station mast is mounted consist of a couple of long heavy timbers, and the mast is erected near one end of these at a point where two cross-timbers intersect or are framed into the skids, one at right angles and the other parallel with them, forming a cruciform base to which is secured four short guy ropes, used to steady the power-station mast during the operation of shifting from one position to another, which will be described later. At the other end of the skids is mounted the engine and boiler for operating the line.

One end of the carrying cable, which is 1⅛ in. diameter, is fastened to a ring at the top of the power-station mast, and the other end after being passed through a sheave-block attached to the top of the spoil-bank mast, is secured by a hemp rope tackle to a dead-man, tree, or stump. The hemp rope tackle serves the purpose of stretching the carrying cable to the proper tension for work, or letting it out during the operation of shifting.

The preferred form of engine is one with double cylinders, three drums placed tandem fashion, and an upright boiler, all mounted on one bed plate. The drums are set at slightly different elevations, or in steps, as in the usual arrangement of hoisting engines of this type, the back drum being the highest and the forward drum the lowest, in order that the ropes from the middle and back drums may not interfere or come in contact with the drums over which they pass. The drums are driven independently of each other through friction connections, operated by hand levers, and are also fitted with brakes operated by treadles.

The rope from the back drum which is used in the operation of loading the bucket and is known as the loading rope A, fig. 2, passes through a sheave block at the top of the power-station mast, thence through a similar block anchored to a dead-man in the bottom of the canal, at a point some distance from the cableway, and thence to a fastening on the bail of the bucket. The rope from the center drum is used for hoisting, also for hauling in from the spoil bank, and is known as the hoisting rope, B. fig. 2. It passes through a sheave block at the foot of the power-station mast, and thence around a sheave in the hoist carriage to a fastening on the bail of the bucket. The rope from the forward drum is used in hauling the carriage out to the spoil bank, and is known as the out-haul rope, C, fig. 2. It passes first through a sheave block at the foot of the power-station mast, thence between idler wheels in the hoist carriage to a sheave block at the top of the spoil-bank mast, through this to a block attached to the carriage and thence to a link on the bottom of the bucket in the middle of one side. The operating ropes are all ⅝ in. diam. and the several blocks are secured by means of chains.

The style of carriage used is illustrated in the accompanying cut and consists of a pair of iron side plates, between which are two upper sheaves that traverse the carrying cable and a lower sheave around which the hoisting rope passes. The sheave-block through which the out-haul rope passes is attached by a link at the back.

The bucket tapers from the top down and in shape is that of a truncated wedge. The bail is rigidly fastened to the body, and the link to which the end of the out-haul rope is fastened, as already stated, is at the bottom edge in the middle of one of the flat sides, the position of which is quite important as will be better understood when we describe the operation of dumping. The upper plates on the flat sides are of crucible steel drawn to a knife edge, so that the bucket may plough or cut its way readily through the material to be excavated.

The operation is as follows: Starting with the bucket in the bottom of the canal, directly under the cable line, and lying on one of its flat sides, (it matters not which), the loading rope is put into action, dragging the bucket horizontally along the bottom until it scrapes itself full, when the engineer places his foot gently upon the treadle connecting with the brake of the loading drum, throwing out the power friction at the same time, and applying power to the hoisting drum, also just enough power to the out-haul drum to keep up the slack of the out-haul rope. The object of applying the brake to the loading drum, is to bring the bucket into a vertical position before hoisting, and thus prevent the load spilling. As it comes back under the line; the engineer releases the brake on the loading drum, and allows the loading rope to run slack. The bucket is raised sufficiently to clear the bank and obstacles under the line, when the engineer applies the brake to the hoisting drum, simultaneously throwing out the power friction on the same, and applying power hard to the out-haul drum. The bucket moves out above the spoil-bank and continues to rise at the same time, by reason of the hoisting rope being held taut, which is necessary to keep the bucket from turning upside down. When the bucket reaches the desired elevation, the brake on the hoisting drum is loosened slightly and just enough of power applied to keep the bucket right side up until the dumping point is reached. A bumper on the carrying cable stops the carriage and prevents the bucket from dropping in the act of discharging. When the carriage reaches a point within two or three feet of this bumper, the steam is shut off from the engine, the power being still applied to the out-haul drum, and the brake taken off the hoisting drum, when the bucket swings back and at the same time turns upside down. It does so with a jerk which very effectually clears it of its contents, but to ensure a good discharge every time, it is important that the bucket should fall flat side horizontal, and hence the reason for placing the link to which the out-haul rope connects in the middle edge of one of the flat sides. After dumping the power is taken off the out-haul drum and the brake gently applied; the steam is turned on, and power applied to the hoisting drum. When the bucket reaches a certain point the power on the hoisting drum is taken off, the bucket drops, and at the same time moves forward, till it reaches the center of the canal when a bumper on the carrying cable similar to the one over the dump arrests the motion of the carriage, and the bucket drops vertically into the canal. During this operation sufficient power is applied to the loading drum to take up the slack of the loading rope.

If it is desired to land the bucket for loading at a point not directly under the line but some distance from it in a direction opposite to that in which the bucket is dragged in loading, so as to get a longer pull on it, which is frequently necessary to

COMBINED CABLE EXCAVATOR AND CONVEYOR. AT WORK ON THE SUWANEE CANAL.
James R. Hall, Inventor; The Trenton Iron Co., Trenton, N. J., Builders.

obtain a full load, especially after most of the loose material has been removed, it can be done in either of two ways.

First: The empty bucket is brought to a point within a few feet of the bottom of the canal, when the brake is applied to the hoisting drum and power to the loading drum, bringing the bucket up to a position where the hoisting rope makes an angle of about 45° to the vertical. The loading rope is then released, and the bucket swings back through the canal to the opposite side of the cableway, and upon reaching the extreme point of oscillation, the brake of the hoisting drum is taken off and it drops to the bottom in the desired position for loading.

Second: By attaching a hemp rope to the link on the bottom of the bucket, passing it through a sheave block anchored in the bottom of the canal on the side of the cableway opposite in direction to that of the loading rope sheave block, and thence to a winch-head on one end of the hoisting drum shaft and by this means hauling the bucket back to any desired distance within the reach of the other ropes. A plough is used in breaking up the bottom after it has become too hard for the bucket to fill easily.

The operation of shifting the apparatus from one position to another is performed in the following manner: The bucket is first deposited on the spoil bank, and all the ropes lowered to the ground, the carriage having been previously placed so that it will drop in a convenient spot for oiling the bearings and otherwise overhauling it. The guy ropes are all loosened, the blocks in the bottom of the canal removed, the loading rope detached from the bucket, and pulled entirely out of the blocks through which it is rove. Before loosening the ground guys, the shorter guys which anchor to the ends of the cross timbers at the base of the power station mast, are tightened. The ropes and tail block through which the out-haul

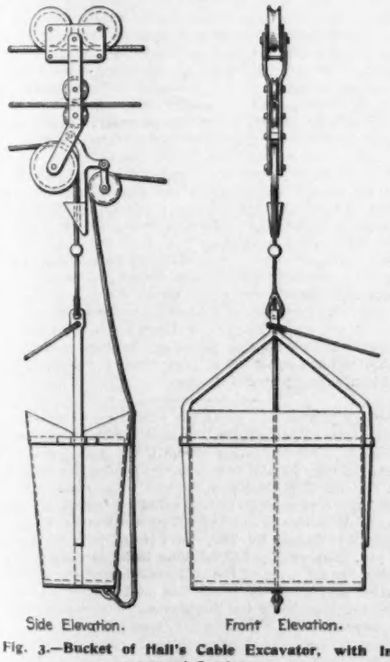


Fig. 3.—Bucket of Hall's Cable Excavator, with Improved Carriage.

rope passes are then disconnected from the spoil-bank mast and anchorage, and attached to a similar mast and anchorage, about 50 ft. further on. A couple of blocks are attached to a dead-man about 50 or 60 ft. ahead of the power-station mast, and a couple more to the skids near the foot of the power-station mast,. Through these blocks the loading rope is rove and the end properly secured. Power is then applied to the winding up of the loading rope, and the whole rig on the skids moves slowly forward. The distance moved at each shift is usually about 25 ft., two shifts of the power-station cast being made to one of the spoil-bank mast. The dead-men or stumps serving as anchorage for the various guys and blocks are prepared in advance while the work of excavation is going on. After the power-station is moved, the loading rope is rove again through the blocks at the top of the mast, and in the bottom of the canal, (the latter have been moved ahead to the anchorage prepared for it) and the end attached to the bucket as before. The mast guys are se-

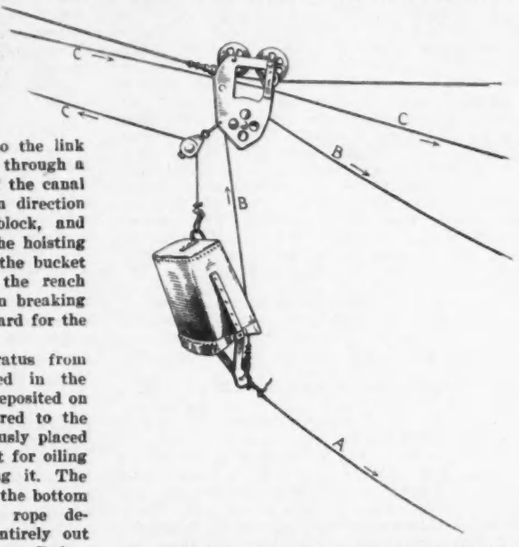


Fig. 2.—Method of Attaching Ropes to the Bucket of Cable Excavator.

curely fastened to the anchorages prepared for them, and hauled up tight, and finally the carrying cable is stretched up into position, lifting the carriage and other ropes with it ,and the work of excavating is resumed.

An objection which may be raised against the method of operation described is that in hauling out to the spoil-bank mast the brake must be applied to the hoisting drum to keep the bucket from spilling, which appears to be placing an unnecesary duty on the engine, and a heavy strain on the hoisting and out-haul ropes. To obviate this objectionable feature it is proposed to provide the carriage with a latch or hook, that will support the loaded bucket in out-hauling, so that the hoisting rope may run slack, as shown in Fig. 3.

The severest work is the operation of loading, and the loading rope therefore only lasts a comparatively short time, but it can be quickly replaced without disturbing the other ropes. The sheave blocks through which this rope works should be as large as possible without being too cumbersome.

The operation of shifting requires from an hour to an hour and a half; and out of eleven working hours, three are consumed on an average in moving, oiling, making repairs, etc. The men required are one engineer, one fireman, one helper, and one other man who watches the bucket, signals the engineer, and attends to other duties. A couple of men are employed in setting masts and preparing anchorages for the successive moves. The output is from 250 to 300 cu. yds. per day for each line, according to the nature of the material. The material is dumped about 80 ft. from the edge of the canal. The cost of operating is about $12 per day, including fuel and oil, or taking everything into consideration the cost is about 6 cts. per cu. yd. With more favorable conditions than those encountered in excavating the Suwanee Canal, conditions for instance conforming to a larger output and cheaper fuel it can be readily understood how the cost might be reduced materially.

A monument to the late Mr. Richard M. Hunt, the noted architect, in the form of a gateway to the entrance to Central Park at 59th St. and Fifth Ave., New York city, is proposed by the Architectural League of New York. The idea is to carry out the plan for the gateway as designed by Mr. Hunt in 1865, the total cost of which is estimated at $190,000.

The abolition of grade crossings at Newark, N. J., will probably be effected eventually, and the problem of devising a practicable and satisfactory plan for a separation of the grades of the streets and railways has been put in the hands of a commission consisting of Mr. Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer of the Pennsylvania R. R.; Mr. J. F. Thompson, Engineer of Construction of the Central R. R. of New Jersey, and Mr. A. P. Boller, M. Am. Soc. C. E., Consulting Engineer for the city of Newark.

In the suit between the Pennsylvania R. R. and the Junction Connecting Railway, as to the crossing of the latter under the tracks of the former at Jersey City, N. J., noted in our issue of Feb 6, the Pennsylvania R. R. has been found guilty of contempt of court in placing cars on its tracks so as practically to prevent the carrying out of the work by the Junction company, as authorized by the court.

The mileage of railways in Canada at the end of 1895 was 16,091 miles, an increase of 325 miles over the previous year; there were also 2,054 miles of sidetrack. The operation of the government lines showed a net loss of $54,997; the Intercolonial Ry. having a profit of $3,815, the Prince Edward Island Ry. a loss of $83,250, and the Windsor branch (maintained but not operated by the government, which takes one-third of the receipts) a profit of $24,437.

A fast run from Galesburg to Mendota, Ill., on the Chicago, Burlington & Quincy R. R., is reported as having been made Feb. 9 by a train of four cars, the distance being 80 miles. The train left Galesburg at 12:04 and arrived at Mendota at 1:32.30 p. m., after making four stops, the actual running time being 1 hour 20½ minutes.

A bill to reduce the fire test of illuminating oil from 300° to 150° has been introduced in the New York Legislature, and is generally considered to be in the interest of the New York elevated railways, which now use an oil decidedly below the present legal standard, as proved by tests by the State Board of Health.

A bill regulating railway rates has been passed by the House of Representatives of South Carolina. The bill provides that no railway company, chartered and doing business in that state, shall charge any higher rates for transportation of passenger and freight within the state than are or may be fixed by the railway commission of the state, unless such rates shall be thereafter determined to be unreasonable.

A bill for lowering the grade of the Pennsylvania R. R. through Washington, D. C., so as to eliminate the present grade crossings, has been introduced by Senator McMillan.

The first electric locomotive manufactured under the arrangement entered into some time ago between the Westinghouse Electric & Mfg. Co., of Pittsburg, Pa., and the Baldwin Locomotive Works, of Philadelphia, Pa., has been completed at the latter works and sent to Pittsburg. It is 38 ft. long and 9 ft. wide over all. The operating parts are all placed on the truck, the body or cab containing only the controlling apparatus, so that it may be utilized as a freight or baggage car, or for carrying the wrecking tools, etc., usually carried by a train. One of the characteristic features of the locomotive is the truck, which has eight wheels 42 ins. diameter, and four motors of 200 HP. each, one to each axle. The entire weight of the locomotive, 160,000 lbs., is thus available for traction. The motors are geared; this method having been decided upon so as to enable the company to use more efficient and durable motors, and it also greatly reduces the cost of the locomotive. It is stated that while the electric locomotive used in the Baltimore tunnel cost $50,000, the Baldwin-Westinghouse locomotive will cost less than one-third of that amount, and will be able to accomplish the same work. The Baldwin-Westinghouse combination will construct engines for road and switching purposes on ordinary railways for suburban and elevated railways, mines, etc. The one just built is intended for passenger service, being rated at 1,000 HP. capacity. It is expected that the second locomotive completed by the Baldwin Works will shortly be received at the East Pittsburg factory of the Westinghouse Electric & Mfg. Co. This is intended for elevated railway work, and is an example of a motor car adapted for the Manhattan Elevated R. R. of New York. As to the speed of these new locomotives, it is stated that the motors have been geared to produce a speed of 75 miles an hour, although 125 miles per hour may be attained if demanded. All the locomotives will be equipped with air brakes, operated in the usual manner by an air pump underneath the car and driven by an electric motor. They can be used with the trolley system, the third rail system, the Westinghouse electro-magnetic system or in connection with the Tesla polyphase system.

The use of a 6-in. concrete foundation for street railway tracks is advocated by Mr. J. Y. McClintock, Cy Engr. of Rochester, N. Y.

An electric railway, 4½ miles long, is projected by the Water Board of New Bedford, Mass. It would lead from the New York, New Haven & Hartford R R. to a new pumping station, extending along the right of way for the pipe line. It would be used to haul material during the construction of the pipe line and to haul coal to the pumping station after the extension is completed.

A competitive run of motor carriages is to be made on May 30, from City Hall Park, New York city, to Irvington, N Y., and back again, making a round trip of about 50 miles. The trial has been arranged for by the proprietors of the "Cosmopolitan Magazine," who offer $3,000 in prizes.

The city of Helena, Mont., will probably be enjoined from receiving bids for building water works. A lower court has ruled that the State law is constitutional which provides that before establishing works of its own a city must buy any existing private works. The ruling was made on a preliminary hearing in a suit brought by the Helena Consolidated Water Company to prevent the city from securing bids.

Leakage of the pumps connected with the water works of Buffalo, N. Y., is reported as 12,972,209 gallons per day, the nominal capacity of the seven pumps being 115,000,000 gallons. The leakage is attributed to "imperfect filling of the water cylinders, tardy valve closing, and leakage between the plunger and ring." The figures are the result of an extended examination of the pumps made by Mr. Newcomb Carlton, who was recently employed for the purpose. He says the leaks are largely due to the excessive demands upon the pumps which prevent shutting down for needed repairs.

Meters for all water in Nashville, Tenn., are proposed by the Board of Public Works of that city. An ordinance to this end passed the second reading in the City Council on Feb. 12. The minimum meter rate is $10. The range of charges per 1,000 gallons is not given.

The cost of a general electric subway system for Baltimore, Md., is estimated at $1,467,000 by N. S. Hill, Jr., Engineer of the Electrical Subway Commission. Mr. Hill reports 24½ miles of conduits already built in that city, containing 363,385 lin. ft. of ducts. Nearly 75 % of these conduits were laid under cobble pavements, and the remainder under Belgian and asphalt block, and a small portion beneath sheet asphalt pavement. The average cost of laying these conduits was $3,051 per mile. The city has laid these conduits for its police telegraph and fire alarm wires, and Engineer Hill strongly recommends legislation requiring all wires to be placed in city subways and that an annual rental be charged for their use.

Business on the Manchester ship canal is improving, says the Manchester "Weekly Times," and merchants are beginning to realize the true value of this waterway. The canal was formally opened to traffic on Jan. 4, 1895, and the first year's report was very discouraging to all concerned. During the last eleven months, says the "Times," the improvement in business has been at the rate of nearly 70 %, as compared with the same 11 months in the previous year. The trades mentioned as especially growing are wood-pulp to the Rosendale, paper-making district, timber from Canada and the Baltic ports and the fruit trade. Of cotton, 7,000 bales have been brought up the canal in the period stated; and, in all, about 2,000,000 tons of cargo were carried last year, of which more than 1,000,000 tons paid toll. Outgoing cargoes are also increasing in bulk, much of this being machinery for Japan and the East. The constant dredging necessary in the canal is the heaviest item of maintenance, though the managers expect this will decrease as measures go into effect for preventing the pollution of inflowing streams.

Six battle-ships and 25 torpedo-boats are asked for by Secretary of the Navy Herbert. In his testimony before the Naval Committee, Mr. Herbert stated that while only two years ago vessels of the "Indiana" type cost $3,000,000, the "Kearsage" and "Kentucky," of 1,000 tons greater displacement, are now being built for less money, and will be in every respect better vessels than the "Indiana." The average price per ton of these latter ships is $195, while the "Indiana," "Oregon," "Massachusetts" and "Iowa" averaged nearly $230 per ton. He said that the English-built battle-ships of 14,500 tons cost about $165 per ton; and while England would always have some advantage in price, owing to cheap labor and lower transportation charges on material, few other naval powers could build ships as cheaply as ourselves, and no power can build better ships than the United States. Secretary Herbert said it would require fully one year to get out the plans, call for bids and make the contracts for the vessels he recommends. Both the Senate and the House favor battle-ship construction and the building of torpedo-boat destroyers, and liberal appropriations are expected.

The bill to regulate the height of buildings in the city of New York, now before the New York Senate, contains the following provisions: No building to be hereafter erected in New York and intended to be occupied, in part or whole, by working rooms, living, sales or storage rooms, for offices or manufacturing purposes, shall be of greater height above the curb-level, at the centre of the front, than 15 times the square root of the width of the street, road or avenue on which it is to be erected. When the street or avenue exceeds 100 ft. in width, 100 ft. shall be taken in making this calculation. But if any portion of a building is set back from the street line, that part may be carried up an additional height of twice the distance set back. At corners, the front on the narrower street may be built to the height of the front on the wider street for a length of 100 ft. On lots fronting a public square, on avenues more than 100 ft. wide, or opposite the end of a street more than 60 ft. wide, buildings may be erected to a greater height than that above specified, on plans approved by the superintendent of buildings, Health Department and a member of the Council of the Fine Arts Federation. This bill, sent in by the City Club of New York, in nowise effects buildings already erected or under contract and commenced within 60 days of the passage of this act, which practically limits the height of buildings to 150 ft.

A bill to fix the maximum price of electric lights in New York and Brooklyn at ¾ cts. per lamp per hour for incandescent and 4 cts. for arc lights has been introduced in the New York Legislature.

For the improvement of the New York water front, President O'Brien, of the New York Dock Department, asks the Sinking Fund Commission to authorize the issue of $2,000,000 of bonds for the present fiscal year. The department could use $3,000,000, which is the limit of appropriation for any one year, as much property must be secured under condemnation proceedings. Mr. O'Brien says he proposes to apply to the Legislature to raise the limit from $3,000,000 to $5,000,000; though this effort will meet with opposition from the Mayor and Comptroller Fitch. Meanwhile Mayor Strong favors the construction of the graving docks, recommended by the board of consulting engineers; the estimated cost of a single dock is $800,000.

A new Brazos River navigation company is being organized, says the "Times," of Dallas, Tex., to promote navigation between Waco and Richmond, Fort Bend County. Mr. John Wilson, engineer to the company, engaged in several water-works projects on the Upper Brazos, suggests, as a means toward the end proposed, slack-water navigation by movable dams. He estimates the cost of this improvement at $2,500,000, and leaves those interested to "work out the greater problem of raising the money."

Greater speed in execution is asked for in the 1885 project for improving the Delaware Bay approach to the harbor of Philadelphia, and a committee made up of municipal and commercial bodies of that city is urging this action upon the Committee on Rivers and Harbors, at Washington. The project referred to was to provide a channel 600 ft. wide and 26 ft. deep at low water, from deep water in Delaware Bay to this city, for the sum of $2,425,000. Of this sum only $920,913 has been expended. According to the report of Major C. W. Raymond, Engineer Corps, U. S. A., this channel, before improvement, was less than 26 ft. deep over an aggregate of 20 miles, and less than 24 ft. deep over 6 miles; the total length of channel to deep water being 61 miles.

Nearly one-fourth of the illuminating gas manufactured in Philadelphia is unaccounted for except by leakage and other wastes, the exact quantity lost in 1895 having been 1,002,140,315 cu. ft., of a total of 4,422,752,000 cu ft. The gas works are owned and operated by the city, but of the total output just mentioned 1,694,687,000 cu. ft. are water gas bought from a private company. The city manufactures coal gas only.

The completion of the topographic survey of Baltimore will cost $31,000, and Major Henry T. Douglas, Chief Engineer of the survey, recommends that this sum be appropriated, and a further sum of $4,000 for engraving and printing a general map of the survey. Maps of sections of the work have already been published.

A combined ice-boat and harbor defense ram is proposed for the harbor of Philadelphia in a plan submitted by Mr. Howe E. Danzenbaker, a naval architect of that city. The proposed boat would have a plow-like bow, intended to cut and lift the ice instead of riding on top of it and breaking the ice down, as in present practice. It would be fitted with twin screws, 4,000 HP. triple expansion engines, and would be very strongly built, with numerous water-tight compartments. To fit the vessel for harbor defense the designer would place in two turrets two 10-in. and two 8-in. guns, and mount heavy side armor. The vessel in action would have only 24 ins. of free-board, and in addition to her winter duty might be used as a practice boat by the naval militia. The estimated cost, exclusive of guns and armor, is $250,000.

A new roofing material has been invented by a Mr. Kohler, of Limbach, Saxony, and after a test of several years it is now being largely used. It is made of 1 part cement to 3 parts of sand and gravel, molded into the form of a tile, which has ridges on the bottom fitting into grooves in the top of the under tile. These tiles are fastened by nails only. It is very cheap and weighs 76 lbs. per sq. yd. It is durable, fire, wind and waterproof, and two establishments in Germany have already turned out nearly 20,000,000 of these tiles in the last few years. It looks as well as slate, and is said to be as durable, and is cheaper and easier to put in place.

A new kind of fuel has recently been made in Boston. It is a mixture of Mexican asphalt and peat or turf, compacted and baked together. There are said to be exhaustless deposits of bitumen or asphalt in Mexico, which the people there have attempted successfully to burn, but it would melt and run and thus give trouble. Mr. George J. Altham, of the New England Turbine and Fuel Co. of Boston, experimented with it, and found the running could be prevented by making a certain composition of it with peat. The compressed fuel was tried on Feb. 7, at the headquarters of the Boston Fire Department, by running a fire-engine with it. It got steam up quicker and held a higher pressure while the engine was operating than cannel coal would do, with a smaller consumption of fuel for a given amount of work.

A safety cartridge for fiery coal mines, where the flame from blasting explosives is very dangerous, is said to have been tried successfully at collieries in Austria. A quick-lime cartridge and a dynamite cartridge are connected, the slack lime heating a primer sufficiently to fire off the detonator embedded in the dynamite. The compound cartridge is enclosed in a bag of cotton, woven like a wick. Experiments were made in a gallery containing 7 % of methane and a great deal of coal dust that was kept in motion, and in no case did the explosion of the cartridge fire the gases or the dust, the flame being confined to the interior of the cartridge, and stopped both by the slacked lime and the water in the bore hole at its upper end.

Nova Scotia coal is to be shipped to Boston, there put into Otto-Hoffmann ovens and split up into coke, fuel and illuminating gas, and numerous by-products. The fuel gas will be distributed by pipes into Boston and neighboring towns within a radius of 25 miles, and the coke will be shipped to foundries and blast furnaces at so low a cost as to revive the iron industry of New England. Such in brief is a project which several capitalists in Boston have been quietly developing for some time, and which now comes before the public in the shape of a petition and bill introduced in the Massachusetts legislature on Feb. 5, to give Mr. Henry M. Whitney, his heirs and assigns, authority to furnish the public with cheap coke and gas, to take land for pipe lines and to do other things necessary for the manufacture, distribution and sale of his product. Mr. Whitney agrees that he will not charge more than 35 cts. per 1,000 cu. ft. for gas delivered by him to a holder or central distributing point in any city or town, or 50 cts. per 1,000 cu. ft. for gas delivered to individual consumers, but he prescribes that he shall not be subject to any provision of law regulating the illuminating power of the gas.

The completion of the survey of the upper Hudson Valley is the subject of a bill now before the New York Legislature, appropriating $20,000 for this purpose. Under the law of 1895, $8,000 was expended in conjunction with the U. S. Geological Survey, which contributed $1,000 more, or one-half of the cost of the topographical survey. With this $12,000 over 750 square miles of the rugged Adirondack territory have been surveyed and mapped. The work yet to be done includes the survey of 2,000 square miles of the Adirondack wilderness, the detailed survey of about 20 dam and reservoir sites, additional gagings of the Hudson and the canals, and the preparation of plans and estimates for storing the flood water of the upper Hudson. From the data already available and plotted the deduction is made that with storage enough to insure a constant flow of 4,500 cubic feet per second, at Mechanicsville, N. Y., the depth of water in the Hudson at Albany would be permanently increased at least 18 ins. The surveys indicate that this storage can be secured. These surveys and investigations have thus far been made by George W. Rafter, M. Am. Soc. C. E.

The contracts for secs. 2 and 3 of the Nashua Aqueduct have been awarded to E. D. Smith & Co., of Philadelphia, for $122,398 and $218,428, respectively, by the Metropolitan Water Board, of Boston. The detailed bids are given elsewhere in this issue. The specifications for this work were abstracted at length in our issue of Jan. 23, 1896, and the whole metropolitan scheme was described in Engineering News for March 7, 1895.